Instruments and AUTOMATION

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Vol. 27 No. 1
JANUARY • 1954

WHEN IT'S LIQUID LEVEL CONTROL

...it's FISHER®

FISHER®

LEVEL-TROL

...the Accepted Standard

for a liquid level controller that is high in sensitivity and accuracy, versatile in handling all kinds of liquids, ruggedly built, easy to operate and simple to maintain.

Write for Bulletin F-3

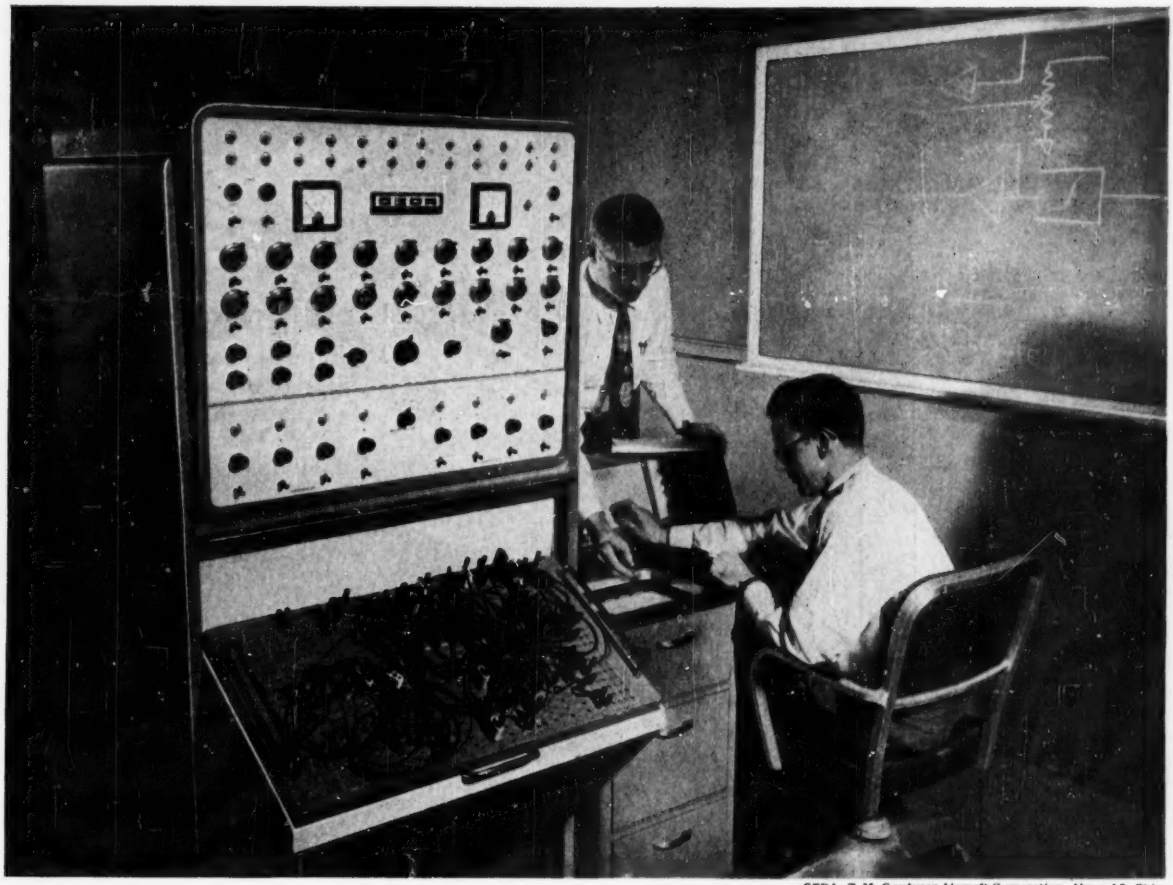
FISHER®

FISHER GOVERNOR COMPANY · Marshalltown, Iowa

WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

For more information circle 1 on inquiry card.

BEST WAY TO GIVE YOUR HUNCH A CHANCE



GEDA—T. M. Goodyear Aircraft Corporation, Akron 15, Ohio

ENGINEERING processes are undergoing a revolution, thanks to GEDA—the Goodyear Electronic Differential Analyzer — a compact analog computer which greatly accelerates the design of complicated equipment and systems.

A big advantage of GEDA is the fact that engineers do not have to learn specialized mathematics in order to use the computer. Once the block diagram is laid out, it is a simple matter to set it up on GEDA's problem board.

The results are shown graphically. Consequently, GEDA provides the engineer with a better understanding of the system under study because the solutions are produced in a form already familiar to him.

So now he is encouraged to "play his hunches." A new idea can be tried out or a component of a system can be changed so easily that new approaches to a problem can at last be profitably explored. Even problems dealing with dynamic systems, where conventional solutions seem impossible or too time-consuming, can be solved by GEDA.

The GEDA line of equipment includes both linear and nonlinear analyzers, six-channel console recorders, and curve-followers—offering flexibility and scope to meet specific individual requirements.

WRITE FOR BROCHURE and details: Goodyear Aircraft Corporation, Dept. D-65A, Akron 15, Ohio — for over five years a major supplier of computing equipment, operator of one of the world's largest computer application laboratories.

GOODYEAR AIRCRAFT

☆ *The Team To Team With In Aeronautics* ☆

We think you'll like "THE GREATEST STORY EVER TOLD"—every Sunday—ABC Radio Network—THE GOODYEAR TELEVISION PLAYHOUSE—every other Sunday—NBC TV Network

For more information circle **2** on inquiry card.

Another Milestone ... the

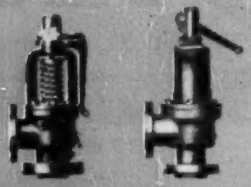
Farris

AFFILIATED COMPANIES

400 COMMERCIAL AVE., PALISADES PARK, N. J.

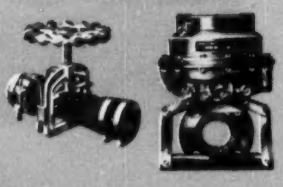
FARRIS ENGINEERING CORP.

Safety & Relief Valves

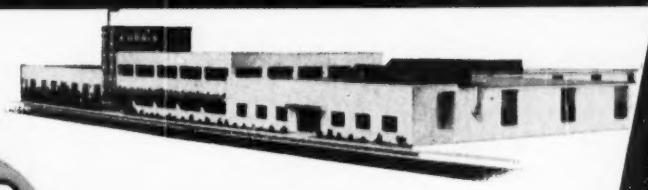


FARRIS FLEXIBLE VALVE CORP.

Pinch Type Flexible Valves



new home of Farris



AFFILIATED COMPANIES

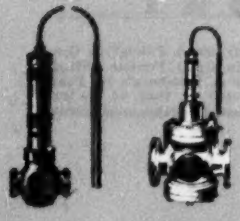
This plant, on a 4 acre tract, is more than an expansion, it is in fact a living thing . . . visual proof that growth in the American way is the simple result of straightforward, sincere effort in giving appreciative customers their money's worth.

In this air-conditioned plant, equipped with the very finest of automatic machinery, we now feel that we have established another milestone; yes, a foundation stone from which our next decade of growth should stem.

Thanks to you, our customers and friends. Thanks to you, our staff, who have truly made the term man-power vibrant.

We shall always keep our operations simple and direct. This effort and thinking has been, and always will be, well rewarded.

FARRIS STACON CORP.
Temperature Regulators



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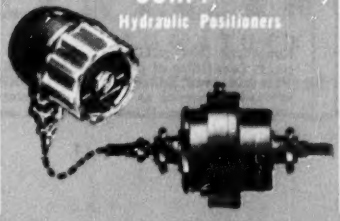
Hydraulic Positioners



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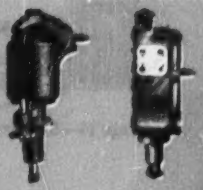
Elastic Piston Seals

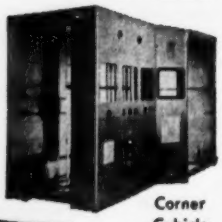
FARRIS PICKERING GOVERNOR CO.
Mechanical & Hydraulic Governors



Quality is assured with
FALSTROM

INSTRUMENT PANELS
and CONTROL BOARDS

Benchboard Console



Five Section Cubicle Control Board and Lighting Canopy

Corner Cubicle Section

Refinery Cubicle with Mimic Flow Diagram in Color

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FALSTROM YOUR LOGICAL CHOICE!

Experienced designing and quality fabrication assure the efficiency of any indicating, recording, or control installation. Whether you are planning new construction, modernizing existing installations or adding to present equipment, FALSTROM offers long years of experience and the most modern facilities for fabricating to your specifications or recommending standard designs. In any case, by specifying FALSTROM you specify the highest possible quality metal working techniques known to the industry. Estimates on your needs will be supplied promptly—call or write FALSTROM to arrange a consultation.

WRITE FOR BULLETIN #125

SINCE 1870 FALSTROM COMPANY
92 Falstrom Court, Passaic, New Jersey
DESIGNERS, ENGINEERS AND BUILDERS OF CUSTOM METAL PRODUCTS FOR INDUSTRY

For more information circle 4 on inquiry card.

Instruments and AUTOMATION

Vol. 27 January 1954 No. 1

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SOUTHERN CALIFORNIA METER ASSOCIATION

Modern Instrumentation Trends 135
By Glen G. Gallagher

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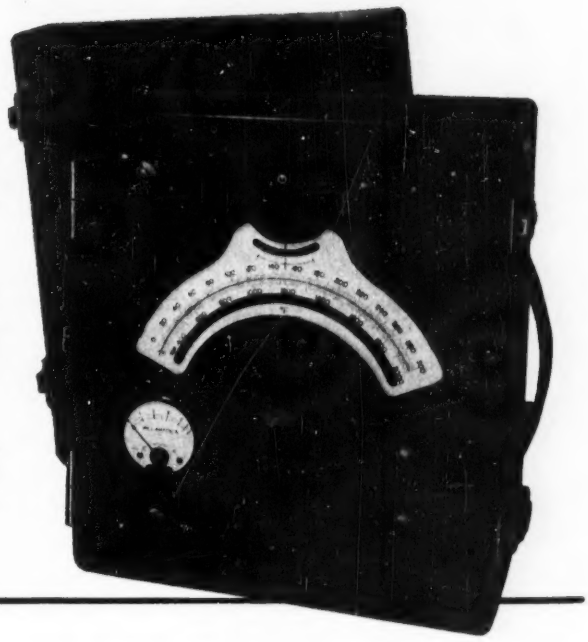
LEWIS PORTABLE PYROMETER POTENTIOMETERS

FOR MEASURING TEMPERATURES ELECTRICALLY

- IN MOVING VEHICLES
- IN AIRCRAFT
- IN THE LABORATORY



ACCURATE, DIRECT-READING, EASILY-OPERATED INSTRUMENTS, WITH ELECTRICAL COLD-JUNCTION COMPENSATION.

These potentiometers have been used for years by the leading motor car and aircraft manufacturers for proving-ground and flight-test work as well as in the laboratory.

- Three models from which to choose the instrument for your application.
  Model 13PO2, with single temperature scale.
  Model 14PO (illustrated) with high and low temperature scales.
  Model 78PO with one temperature and one millivolt scale or two temperature scales, for different thermocouple materials.
- Housed in a sturdy hardwood case, approximately 11⅜" long, 10" wide and 7⅞" high. Weight approximately 17 lbs., shipping weight 20 lbs.
- For dependable temperature instrumentation, use these potentiometers with LEWIS leads, selector switches and thermocouples.

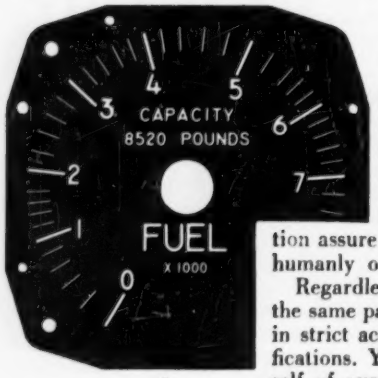
THE LEWIS ENGINEERING CO.
NAUGATUCK, CONNECTICUT

Manufacturers of Complete Temperature Measuring Systems for Aircraft

For more information circle 5 on inquiry card.

Where the INFINITESIMAL .001" is IMPORTANT

AS IN INSTRUMENT DIALS



"MICROSCOPIC-PRECISION" actually defines the minute accuracy of dials *by U. S. Radium* (instrument, clock, or watch), for "microscopic" checks and painstaking inspections in every step of production assure the *highest degree of perfection* humanly or mechanically possible.

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Special equipment and specialized personnel, plus our rigid controls, constant checking and inspection guarantee the fine finished product your order merits. Whether flat or curved, we can produce your panels edge-lighted, and either luminous or non-luminous engraved, etched, screened or lithographed, with the *ultimate in uniformity* and *legibility*.

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The same engineering skill and same plant facilities are yours for the production of nameplates. For years we have been the major source of supply for many industries and our reputation has been built on *attention to detail, prompt deliveries,* and the *economy* effected for our customers.

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ENGINEERING News

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ROTAMETERS • FLOW INDICATORS • RADIATOR TUBES • VALVES • SPRAY NOZZLES AND ATOMIZERS • GEAR PUMPS • DESUPERHEATERS

Here's SK's NEWEST DESIGN for Rate-of-Flow Measurement— the SAFEGUARD ROTAMETER

As an answer to industry's increasing demands for *safety* and *convenience* in rate-of-flow measurement of liquids and gases, SK has designed its newest Rotameter—the Safeguard Rotameter.

This Rotameter has specific application for measurement in the higher temperatures and pressures of modern process technology, or where dangerous or valuable liquids and gases are being used.

FOR SAFETY:

The completely enclosed steel meter case has detachable safety glass windows, protects the metering tube from external shock, and also protects the operator if accidental tube breakage occurs.

FOR CONVENIENCE:

Wider front and rear sight glass windows give maximum visibility. The detachable metal reference scale can be supplied in either units of flow or in millimeters for use with calibration charts, as desired.

Extreme construction rigidity gives precise end fitting alignment, eliminates pipe stresses on the tube.

Can be adapted for remote recording and controlling of fluid rate of flow.

Write for full information, including sizes and capacities, on this newest Rotameter design.

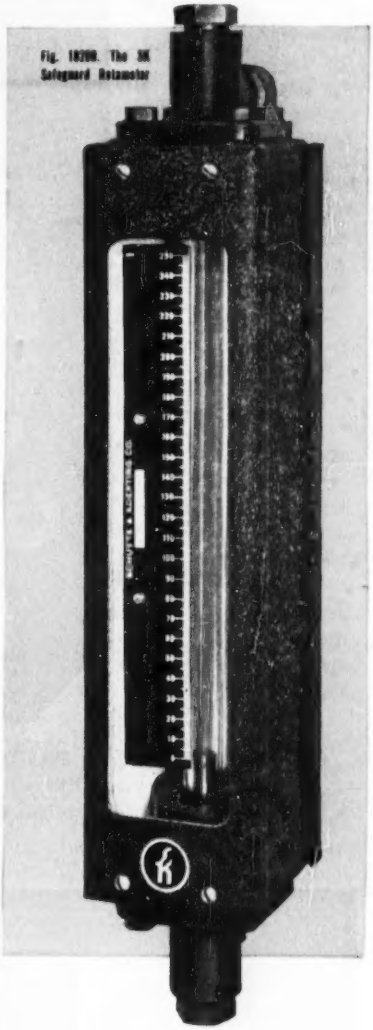


Fig. 1820R. The SK Safeguard Rotameter

Glass metering tube has cylindrical inlet and outlet pieces of the *same outside diameter* — allowing use of the same size packing rings on either end of the tube.

Horizontal inlet and outlet can be connected in four different positions.

Two types of metal mandrel made tubes are available—the "HCF," a High Capacity Fluted tube, or the "R," a conical tapered tube without flutes.

Various rotor designs and materials permit wide capacity range within one meter.

End fittings are available in cast iron, bronze, and stainless steel.

Neoprene packing gives corrosion resistance, tight seal, long service life. Other packing material is available.

Rotor removal and tube cleaning without dismantling easily done through non-leaking seated clean-out plug.

SCHUTTE and KOERTING Company
Manufacturing Engineers
26 STATE ROAD
CORNWELLS HEIGHTS
BUCKS COUNTY, PA.
Representatives in Principal Cities

For more information circle **7** on inquiry card.

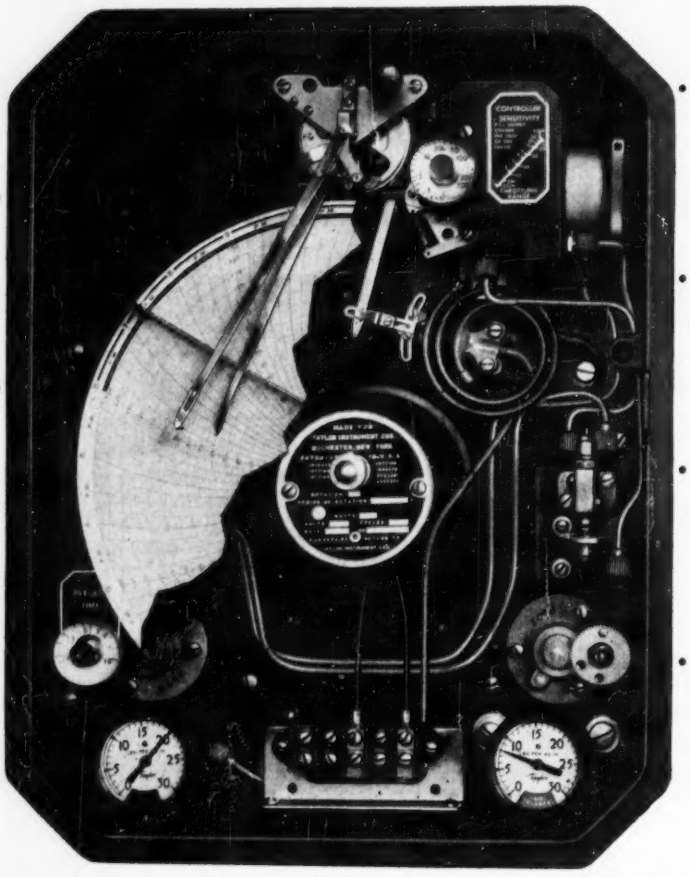
The most popular of all

DEPENDABLE

RUGGED

EASY, LOW COST MAINTENANCE

SIMPLE ADJUSTMENTS



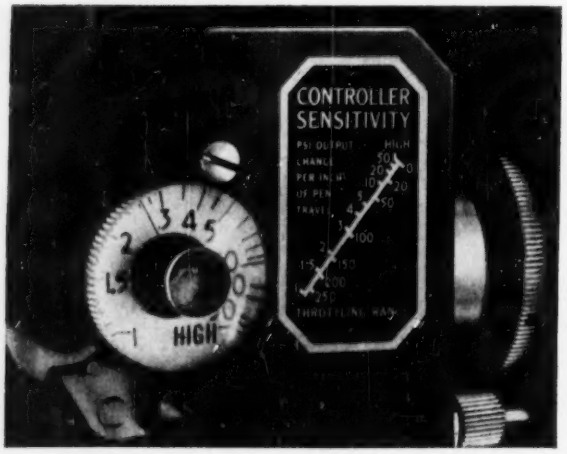
VERSATILE

TROUBLE-FREE

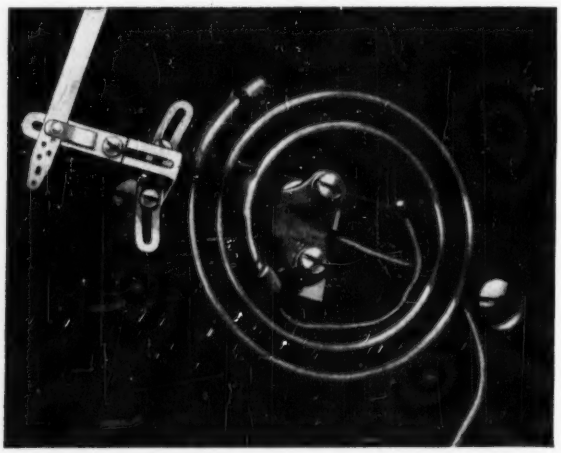
SIMPLE OPERATION

LONG LIFE

Single Duty FULSCOPE Recording Controller with Adjustable Sensitivity, Automatic Reset and PRE-ACT responses. Double Duty control mechanisms, with *any* combination of control responses, afford a great advantage on many applications.



Sensitivity adjustment unit; single, continuous adjustment calibrated in specific units.



Improved sub-base permits easy, precise replacement of pre-calibrated actuating systems in field.

For more information circle 8 on inquiry card.

instruments celebrates its 15th BIRTHDAY !

THANKS to you, the Taylor FULSCOPE* Controller today enjoys unrivaled popularity. We say thanks to you because this instrument was designed to meet your exacting requirements as determined by an industry-wide survey. The result is dependable performance year after year, and low maintenance cost. In the petroleum industry, natural gasoline plants particularly, these instruments are relied upon to operate automatically for hours on end unattended. Thus the operators are freed to take care of other maintenance duties.

For the benefit of those who are new in positions of responsibility in the selection of instrumentation, here are some of the reasons why Taylor Series 100 FULSCOPE Controllers have been able to meet these exacting requirements and consequently reign supreme throughout industry.

ADAPTABILITY

1. Extremely versatile. The same control mechanisms are available for Temperature, Pressure, Flow and Liquid Level—in either recording or indicating models, as locally mounted controllers, transmitters or controlling receivers. Interchangeable unit construction permits a small inventory of parts. Pre-calibrated units eliminate expensive checking. Easy visibility and accessibility of components means an instrument man can have a unit back on the job with minimum down time.

2. Adaptable to any control problem because the FULSCOPE Controller has three control effects:

(a) Proportional Response—available in three forms: Fixed High Sensitivity (1000 psi per inch pen movement): Adjustable Sensitivity (1000 to 1 psi); and Limited Range Sensitivity (400 to 30 psi). **(b) Automatic Reset Response,** completely and continuously adjustable (.05 to 5 repeats per minute). **(c) PRE-ACT* Response** (rate action) continuously adjustable within the range of 0.2 to 10 mins. All the adjustments are wide range and continuous. Any combination of these control responses may be used to provide any required quality of control. PRE-ACT and reset units are interchangeable.

3. Proper Adjustment Easily Obtained. Control Response Adjustment Dials are calibrated in specific units, repeatable in all instruments. Optimum settings are quickly determined.

4. Controller action simply changed by lifting a spring clip and rotating set-point knob.

DEPENDABLE OPERATION

5. Control point always matches set point when automatic reset is used, thanks to fully pneumatic sensitivity reduction. Lowering sensitivity for stability does not reduce the effectiveness of the reset response. Result—control point always returns to set point, regardless of load changes.

6. Trouble-free air system. Metal disc type filters are built-in features, easily removed for cleaning. Both relay air valve and nozzle are made of 18-8 stainless steel. A simple system, made of corrosion resistant parts, easily accessable for cleaning.

7. Lifelong Accuracy. Fewer links and pivots. Dead spot and hysteresis practically non-existent due to lightweight stainless steel link and small diameter burnished pivots. This lightweight construction nullifies vibration effects. Spring pivot clips, which do not gum up or corrode, replace screws. Over and under-range linkage protection provided when required.

Whether your processing problems are simple or complex, there's a Taylor instrument or control system and a competent Taylor Field Engineer ready to help you solve them.

Write for Bulletin 98151. Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada.

Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.

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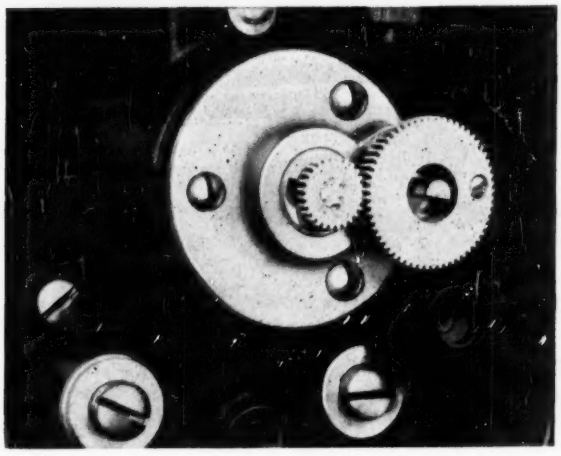
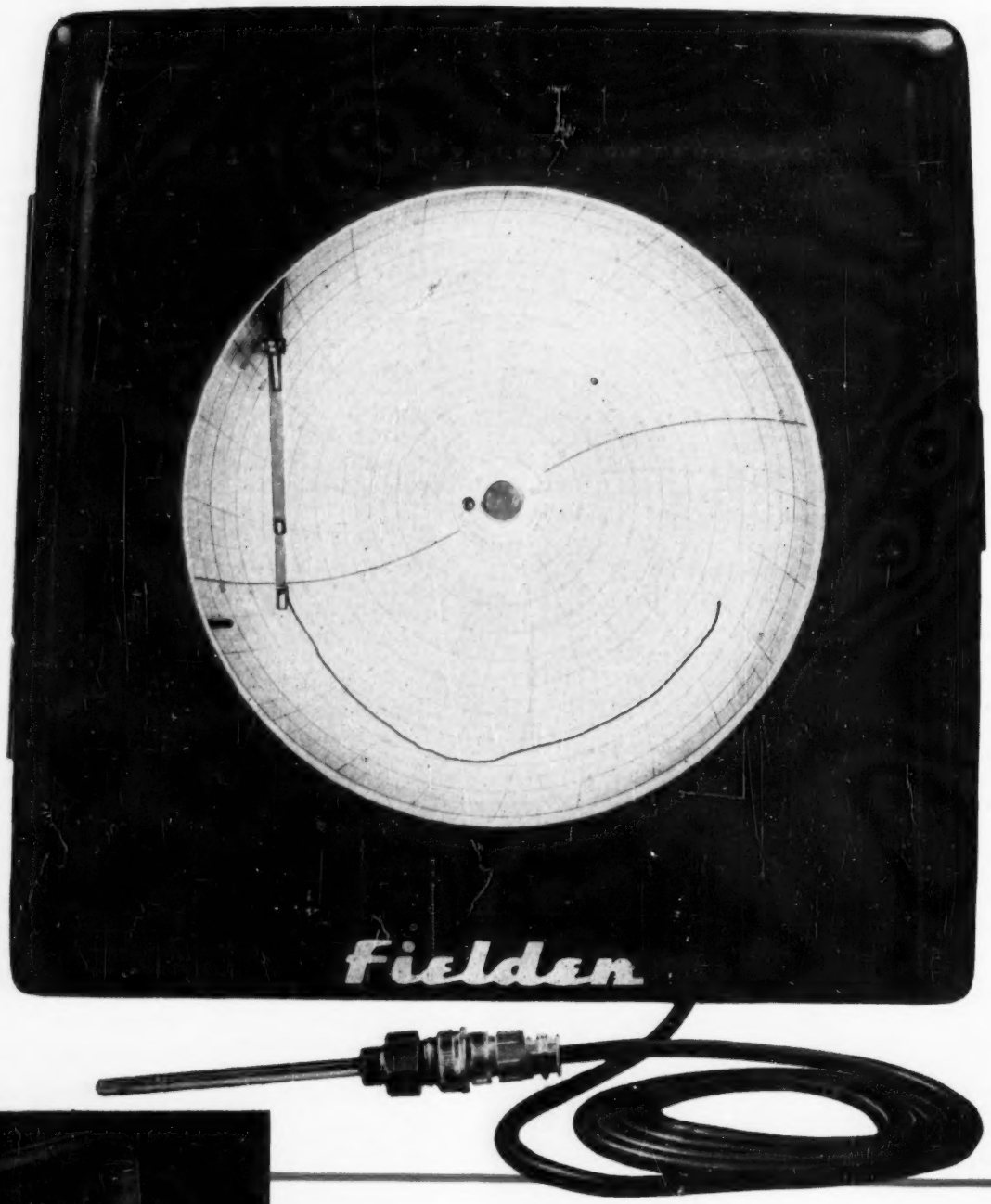


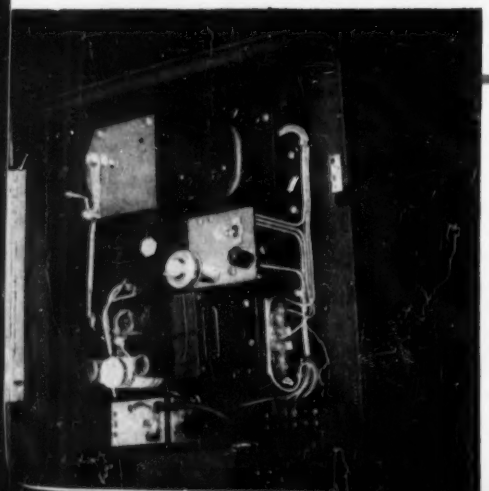
Interchangeable needle valves in Automatic Reset and PRE-ACT units.

Taylor Instruments
MEAN ACCURACY FIRST

For more information circle 8 on inquiry card.

can you pay too much for industrial





Note Absence of Complex, Costly Mechanisms In Electronic Chassis

Simple, sturdy, unitized construction with few units. Low initial cost and easy, inexpensive maintenance. The electronic chassis is compact, with components operating well below their ratings ensuring long service. An AC actuated bridge circuit eliminates direct current source and replacement of dry cells. The complete unit can be changed in a few minutes—and a spare chassis can be supplied for use as a stand-by.

For more information circle 9 on inquiry card.

instrumentation?

fielden says YES—

when you're paying for *sophistication.* This is the hyper-accuracy and fancy features you rarely need—yet these can multiply your instrumentation costs. For most applications, the new Fielden concept of *simplified instrumentation provides all the essentials*—at a realistic price.

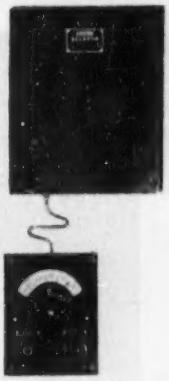
Here is a practical case in point . . .

New Fielden Resistance Thermometer Recorder

This new Fielden self-balancing type recorder measures temperature up to 600°F. with an inherent accuracy of ± 0.5% of full scale. It measures spans of 50°F. or less if required—with linear scale on all spans up to 600°F. Interchangeable bridge units permit change in range and type of measurement without rewiring. Up to 4 simultaneous inputs allow addition, subtraction or averaging.

Other Examples of Fielden Simplified Instrumentation

TELSTOR
Electronic Level Indicator



Circuitry is simplicity itself and only 1 vacuum tube is employed. Yet TELSTOR measures continuously—with accuracies to ±2%—the levels of liquids, divided solids or interface. Readings can be recorded up to and over 1 mile. Maintenance is easy—no floats to stick or leak—no pneumatic or hydraulic tubing. Cost is gratifyingly low.

TEKTOR
Electronic Level Control

Provides level control as close as 1/16" of any material that flows—liquid, divided solid or interface—conducting or non-conducting—wet or dry. Can also be used for accurate indication. No moving parts—only 1 radio tube. Simple failsafe, high-or-low-level control circuit operates visual or audible alarms, motor starters, solenoid valves, timers. Low initial cost—easy installation.

TEKTOLOG
Electronic Recorder

Accurate to ±1% of full scale, yet has simplified design—only 4 principal units. Self-starting operation, directly from low energy sources, with various recording speeds to suit applications. Available with electric or pneumatic controls. Supplied as portable or industrial unit—easily installed by flush or surface mounting. Dust-tight, weather-proof case prevents deterioration by atmospheric or other conditions.

MAIL COUPON FOR FULL INFORMATION

Fielden

INSTRUMENT DIVISION

ROBERTSHAW-FULTON CONTROLS COMPANY

Dollar for Dollar—Your Best Instrument Value

FIELDEN INSTRUMENT DIVISION
ROBERTSHAW-FULTON CONTROLS COMPANY
2920 North 4th Street, Dept. A, Philadelphia 33, Pa.

Send me full details of Fielden Simplified ☐ Resistance Thermometer Recorder, ☐ TELSTOR Indicator, ☐ TEKTOR Control, ☐ TEKTOLOG Recorder.

Name _____

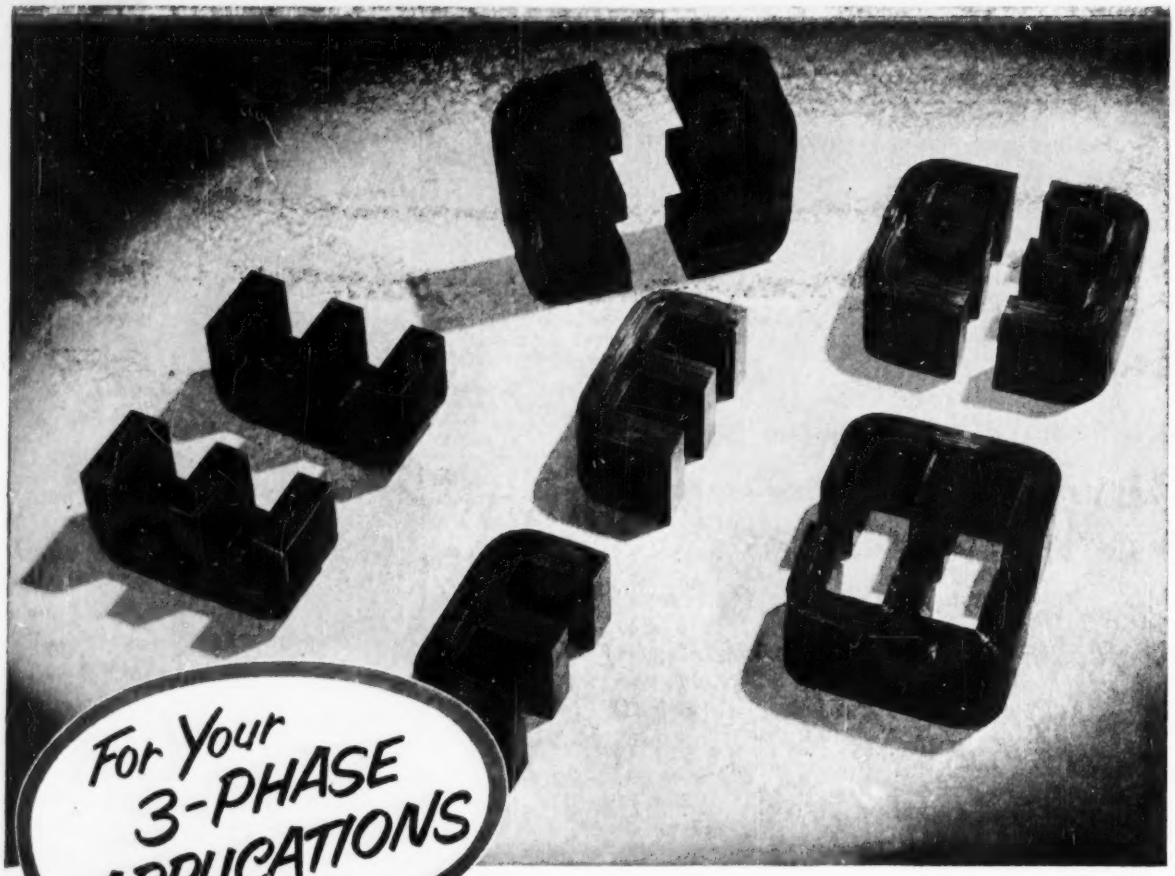
Title _____

Company _____

Address _____

City _____ State _____

For more information circle 9 on inquiry card.



For Your 3-PHASE APPLICATIONS

Arnold E-CORES

made from SILECTRON strip
(grain-oriented silicon steel)

The use of "E" cores, wound from grain-oriented silicon steel, results in weight and size reduction as well as higher efficiency and possible cost savings. "E" cores can be supplied in a variety of window sizes and core areas from 1, 2, 4 or 12-mil Silectron strip, for high or low frequency 3-phase applications. ● All Arnold cores are made by precision methods, and carefully tested under closely controlled conditions to assure highest quality and reliability. *We'll welcome your inquiries.*

WRITE FOR BULLETIN TC-105

C-Cores to meet any requirement

For your single-phase applications, Arnold "C"-Cores are available in any shape and quantity, and in any size from fractions of an ounce to hundreds of pounds . . . wound from Silectron strip in a wide range of ultra-thin and heavier gauges. (Sizes up to 10 lbs. in 12-mil strip; to any weight in thinner gauges.)

WAD 4658

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

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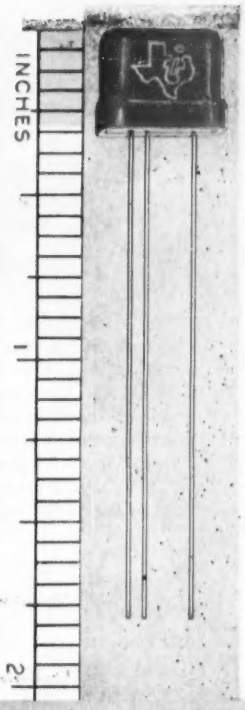
For more information circle **10** on inquiry card.

TI transistors will FIT in Your Future!



FORTY PERCENT SIZE REDUCTION has been made in Texas Instruments junction transistor cases. With case length now less than a third of an inch, TI transistors offer you a major opportunity for equipment miniaturization.

This important size reduction was achieved without reducing the quality or changing the construction of the proven TI junction transistor. Transistor fabrication methods, materials, and moisture-proof glass-to-metal hermetic sealing remain the same.

Texas Instruments junction transistors undergo an exhaustive testing procedure to insure their close adherence to published specifications (see distribution curves below). And not only must all transistors pass more than 20 test procedures—in addition to continual visual checks—but also they are aged over 48 *hours* at rated output. They are then completely re-inspected, as a positive operating double-check.

If *you* want transistors combining small size with high quality, they are now in production and available in five types from Texas Instruments Incorporated. Write for bulletins DL-S 310 (junction) and DL-S 312 (point-contact). Custom-built units also are available.

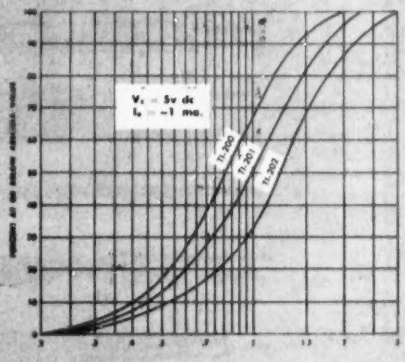
ELECTRICAL DATA:

	n-p-n junction transistors type 200	type 201	type 202	
RATINGS, RECOMMENDED MAXIMUM:				
Collector Voltage	30	30	30	volts
Collector Current	5	5	5	ma.
Collector Dissipation (at 25°C)	50	50	50	mw.
Ambient Temperature	50°C	50°C	50°C	
AVERAGE CHARACTERISTICS (AT 25°C.):				
Collector Voltage	5	5	5	volts
Emitter Current	−1	−1	−1	ma.
Collector Resistance (Minimum)	.4	.4	.4	megohms
Base Resistance	150	170	200	ohms
Emitter Resistance	22	22	35	ohms
Current Amplification Factor* (Minimum)	9	19	49	
Collector Cutoff Current (Maximum)	10	10	10	μa.
Collector Capacitance	15	17	19	μμfd.
Noise Factor** (V_C = 2.5 V., I_C = −.5 ma)	26	23	20	db
Frequency Cutoff** (α_{CO})	.90	1.10	1.30	m.c.

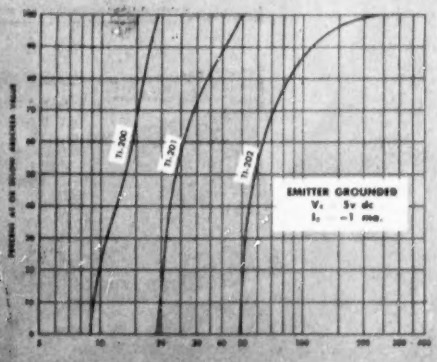
*Emitter Grounded.

**Noise Factor and Frequency Cutoff are average and individual units may vary.

STATISTICAL DISTRIBUTION CURVES
Based on 100 transistors of each type



α_{co} — Alpha Cutoff Frequency — megacycles



K — Current Amplification Factor

TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE DALLAS 9, TEXAS

For more information circle 11 on inquiry card.

Put your finger on

EXTRA DEPENDABILITY

by specifying...

CHESTER means dependability *plus* in wires and cables for every electronic and electrical application. The compounds used in all **CHESTER** Wire and Cable constructions are made in the **CHESTER** plant. Thus, complete control over selection of raw materials and manufacturing techniques, provides full control of quality... your assurance of uniformity in every foot of conductor bearing the **CHESTER** label!

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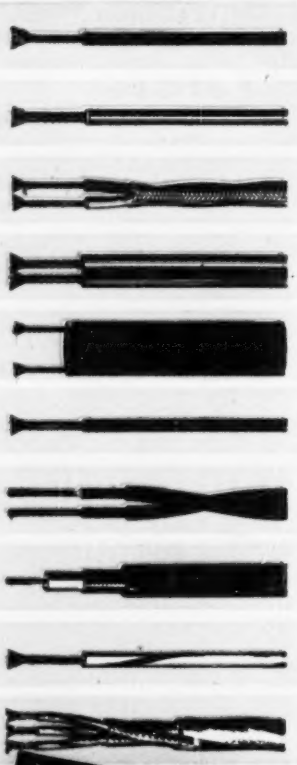
WIRES & CABLES



- JAN-C-76 WIRES* SRIR, SRHV, SRRF, WL
- 105°C, 90°C, 80°C, UL APPROVED; 120°C*
- SHIELDED WIRES & CABLES
- FLEXIBLE CORD
- TV LEAD-IN WIRES
- INSTRUMENT WIRES
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- LACQUERED AND NYLON COVERED WIRES
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*Solid colors or spiral marking

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To specification using Polyethylene, Polyvinyl Chloride, Nylon, Braided and Lacquered Wires, Special Insulating Materials, Glass, Yarn, etc. Inquiries invited.

ASK *"Chesty"* FOR the New Chester Literature. Complete data on wires and cables for electrical and electronic wiring. Request yours, today!

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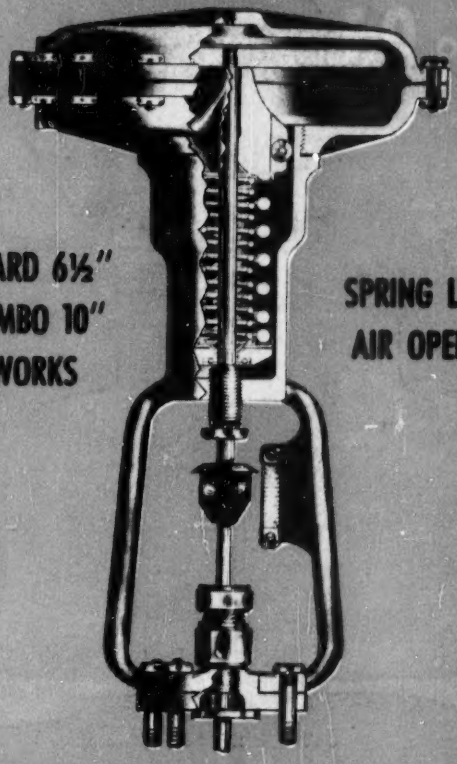
FOR BETTER CONTROL USE BS&B CLIMAX TYPE 86-TW DIAPHRAGM OPERATORS



STANDARD 6½" OR JUMBO 10" TOPWORKS

SPRING LOADED AIR OPERATED

This versatile Climax Type 86-TW Diaphragm Operator is a modified version of the controlling mechanism of the famous BS&B Climax Type 86 Control Valve. It has been adapted for use with a variety of other valves, instruments and controls such as butterfly valves, diaphragm valves (Saunders Patent), engine throttles and other controls where controlling pressure is available for translation to reciprocating motion.

Available in either the Standard 6½" or Jumbo 10" size, this versatile topworks is spring loaded and operates from compressed air or other medium. Yoke, spring case, diaphragm case and plate are of high tensile cast iron. Stems are of stainless steel with bronze connector of unique construction. Diaphragm is of cotton or nylon neoprene. Roller bearings on the spring guide reduce friction loss to a minimum.

For more complete information on the Climax Type 86-TW Diaphragm Operator or on other Climax Controls, ask your BS&B Man or Sales Representative, or write to . . . .

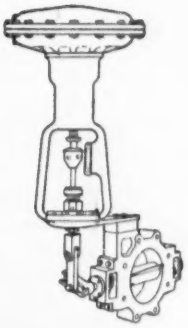
CLIMAX BS&B CONTROLS OVER 60 YEARS

BLACK, SIVALLS & BRYSON, INC.

Climax Controls Division Dept. 4-VI

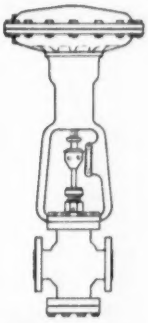
7500 East 12th St. Kansas City 26, Missouri

For more information circle 19 on inquiry card.



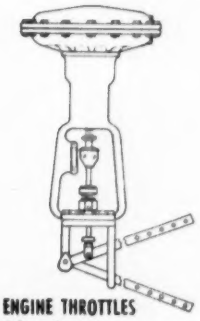
FOR BUTTERFLY VALVES

Climax Type 86-TW Diaphragm Operator is ideal for automatic control of butterfly valves. Mounts easily on any make of valve, and can be set for any specified operation of the valve.



FOR DIAPHRAGM VALVES

First developed for use on diaphragm valves, Climax Type 86-TW Diaphragm Operator has large diaphragm area and variable spring loading to insure minimum hysteresis.



FOR ENGINE THROTTLES and Other Controls

Wherever a sensitive yet positive reciprocal controlling motion is needed, such as on engine throttles, speed governors, cooling tower weirs, valve levers, etc., the versatility and adaptability of the Climax Type 86-TW Diaphragm Operator make it the ideal selection.

AVAILABLE—
A COMPLETELY NEW CONCEPT IN CONTROL VALVE DESIGN..

BODY RATING TO
50,000 PSI
FLOW RANGEABILITY
C_V .000001 TO 0.1

1 Substantial forged alloy (wide selection) valve body.
2 Rugged all stellite, easily removable, Flo-Mike valve seat.
3 Direct positive seal, inlet tubing to valve seat connection.
4 Hard chrome-plated, super finished valve stem with stellite plug.
5 Annin "Super VO" stem seal assembly.
6 Thumbnut valve stem locking unit.
7 Powerful, lifetime lubricated, cross head and drive rod assembly.
8 Simplified combination stroke and valve action adjusting unit.
9 Direct and reverse acting stem stroke adjusting scale.
10 Needle bearing mounted motion converter arm.
11 Cross head pre-loading spring, eliminating lost motion.
12 Exclusive, extra strong, box type frame unit.

And now — Annin's "Wee Willie" — new in concept and design, providing the Research and Development engineer with a pilot plant instrument having a water Cv range from .000001 to 0.1 with control of pressures to 50,000 PSI. Unique design minimizes distortion, stretching, and friction. The time-proven Series "A" Domotor power unit provides precise and positive control under all conditions. "Wee Willie" may be the answer to your problems in the high pressure field. Investigate this new valve today!

"Wee Willie" DOMOTOR VALVES

Write today for bulletin No. 50WW for complete information and engineering data on "Wee Willie"

ANNIN *Control* VALVES

THE ANNIN COMPANY
4170 E. TELEGRAPH ROAD, DEPT. A-214
LOS ANGELES 22, CALIFORNIA

For more information circle 14 on inquiry card.

Circle 15 on inquiry card. →

A Completely Self-Contained

RF BRIDGE

500kc to 250mc

RX METER TYPE 250-A

- **SAVES** valuable engineering labor: makes RF bridge measurements a "means to an end" rather than an end in themselves.
- **INCLUDES** self-contained test oscillator, local oscillator, Schering bridge, detector, and null indicator.
- **INDICATES** directly equivalent parallel resistance and capacitance (or inductance) of any two-terminal network.
- **MEASURES** dynamic and static systems under actual operating conditions.
- **CONNECTS** to unknown from convenient binding posts or Type N coaxial (with use of accessory adapter).

SPECIFICATIONS

FREQUENCY RANGE: 500 KC to 250 MC in eight ranges.

FREQUENCY ACCURACY: ±1%.

RESISTANCE RANGE (Rp): 15 to 100,000 ohms.

RESISTANCE ACCURACY (Rp): $\pm \left\{ 2 + \frac{Fmc}{200} + \frac{Rp}{5000} + \frac{Q}{20} \right\}\% \pm 0.2$ ohms.

CAPACITANCE RANGE (Cp): −100 mmf to +20 mmf.

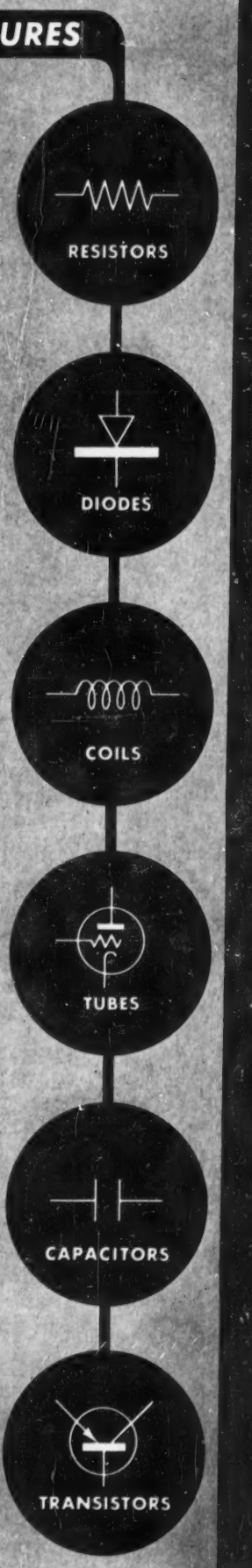
CAPACITANCE ACCURACY (Cp): $\pm \left\{ 0.5 + 0.0002\ F^2\ mc \right\}\% \pm 0.15$ mmf.

TEST VOLTAGE: 0 volts D. C. (Up to 50 ma. may be passed through unknown terminals).
0.1—0.5 volts R. F. (may be conveniently reduced to 20 mv.).

POWER REQUIREMENTS: 105—125 volts, 50/60 cps, 60 watts (internally regulated)

MEASUREMENT APPLICATIONS

Resistors
Transistors
Tubes
Tuned Circuits
Diodes
Transmission Lines
Antennas
Coils
Capacitors
Chokes
Receivers
Filters
Transmitters
Attenuators
Pads



BOONTON RADIO Corporation
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Price: $1250.00 F.O.B. Boonton, N. J.

Trends ...

While economists predict "leveling off" and "readjustment" for most American industries in 1954, the instrument industry expects the search for more efficient ways of production to focus more attention on instruments and automation. Continued rising costs and the ever-tightening squeeze on profits will make all manufacturers drive hard for greater efficiencies. The result: more instruments and automation.

Industrial television by 1960 will be bigger than entertainment TV is now, says David Sarnoff, chairman of the Radio Corporation of America.

Investments in instruments on new plants have risen from 3% to 10% in only five years. H. Dever, President, Industrial Division, Minneapolis-Honeywell Regulator Co., predicts that the investment in instruments on new plants will not level off until about 1957, when the percentage will be about 20%.

"Watch for more revolutionary developments in adaptation of analytical instrumental methods of automatic product control in large-scale manufacturing," says Walter J. Murphy, Editor, CHEMICAL & ENGINEERING NEWS.

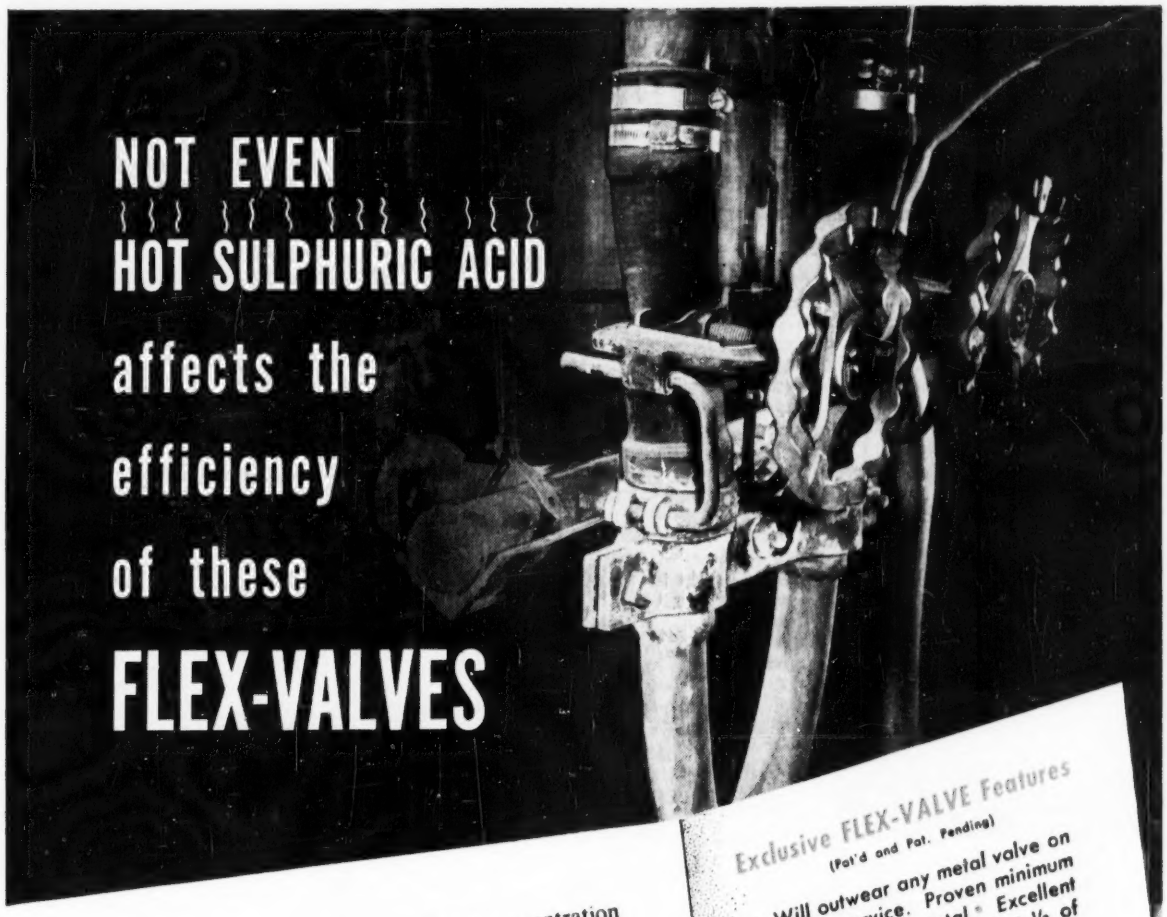
Automation age moves forward, says ADVERTISING AGE, in an article by E. B. Weiss, Grey Advertising Agency. Weiss predicts startling changes in mass retailing. The next steps will be (1) the mechanization of self-service, (2) application of electronic techniques to retail warehousing and office procedures, (3) ultimate employment of electronic techniques on the retail selling floor. The second industrial revolution, the use of instruments and automation, will be accompanied, at a slightly later time, by a second retail revolution.

"Replacement of obsolete machinery and production equipment to meet growing competition is one of the most pressing problems facing industry today," says S. D. Maddock, President, C.I.T. Corporation, the nation's largest industrial financing firm. As the most modern equipment is completely automatic, the level of expenditures for instruments and control equipment must increase as replacement advances.

"Industrial productivity must increase 45 percent in the next ten years," says F. R. Benedict, Industrial Products Div., Westinghouse Electric, in a report "Progress Through Research." He goes on to say: "Additional production could be attained by replacing manual operations on the machines with automatic ones. . . . . Our treasured and incomparable standard of living is based on the steadily rising productivity of our workers. . . . . Automatic processing equipment requires, for its full utilization, automatic materials handling. In this automatic process nearly every human action is simulated. Machines start, stop, push, pull, twist, rotate, grasp, release, lift and carry . . . . . materials handling and the process must be designed together.

Paul G. Hoffman, Chairman of the board, Studebaker Corporation says: "There is absolutely nothing wrong with our economy that a higher volume of hard-hitting advertising and sales promotion by business . . . . could not cure."

Keys to prosperity: More production, more automation, more promotion.



NOT EVEN HOT SULPHURIC ACID affects the efficiency of these FLEX-VALVES

A solution of copper sulphate with a high concentration of sulphuric acid—at approximately 180° F—has failed to give these valves trouble in more than two years. At a leading smelting and refining company*, where precious metals are refined and copper sulphate is produced, FLEX-VALVES have once again proven the superiority of their simple construction and corrosion resistant characteristics. If you have a fluid that's "too hot to handle" for ordinary valves, specify trouble-free FLEX-VALVE. Write for catalog No. FL 382.

*name available on request.

Exclusive FLEX-VALVE Features

(Pat'd and Pat. Pending)

• Will outwear any metal valve on abrasive service. Proven minimum 11 to 1 life over metal • Excellent control characteristics in first 1/8 of travel • Tight on grits up to 1/8" • Valve body available in pure gum rubber, neoprene, butyl, buna-n, buna-s, food stock and special compounds • Full pipe capacity • Will not freeze up in outdoor service • Complete closure for bubble-air tightness • No obstruction, pockets or internal parts.

Your Money Back if it Plugs.

Representatives in Principal Cities

Farris FLEXIBLE VALVE CORP.

610 COMMERCIAL AVE., PALISADES PARK, N. J., U.S.A.

affiliates: FARRIS ENGINEERING CORP. • FARRIS STACON CORP. • FARRIS HYDROSEAL CORP. • FARRIS HYDROTORQUE CORP. • FARRIS PICKERING GOVERNOR CO.

For more information circle 16 on inquiry card.

INSTRUMENTS ON THE MARCH

New Principles, Applications, Non-commercial Developments

20-watt Transistor

PHILA., PA.—This thimble-size power-type transistor developed by researchers at Minneapolis-Honeywell is 100 times more powerful than present commercially available models. It has an output of 20 watts, enough to operate motors, valves, relays and other equipment previously impossible to operate with transistors. Described as a major contribution to the advancement of transistors by Dr. Finn J. Larsen, research director, the new power unit has already been incorporated into a prototype aircraft electronic fuel gauge made by the company, but is not yet in commercial production.

The key to Honeywell's development was the discovery of an effective means of removing heat from the germanium-alloy junction.

"Gyrotron"

GREAT NECK, N. Y.—A new and different kind of gyroscope was disclosed on Nov. 10 by the Navy to gyro experts of the military and industry, in a closed conference at the Sperry Gyroscope Company at Great Neck.

The group discussed future applications and witnessed demonstrations of the new "vibratory gyroscope," which resembles a small tuning fork in contrast to the spinning wheel of the conventional gyro. The instrument has been named the "Gyrotron" by Sperry.

The new instrument is analogous to the gyratory sense organs found on the common house fly. These are club-shaped vibrating rods behind the fly's wings which give the fly his sense of balance. They have functioned as "gyro flight instruments" on certain insects for more than 200 million years. In reducing this principle to practice, Sperry engineers studied slow-motion pictures of insects in flight.

Experimental vibratory gyroscopes consist of small electrically-driven tuning forks which are sensitive to extremely small as well as large turning motions. The experimental units can measure rates as slow as the earth's rotation, or as fast as 100 revolutions a minute.

The principle of operation is illustrated by a simple experiment. If the handle of a vibrating fork is grasped and turned (Fig. 1), an oscillatory twisting motion will be felt. The reason for this reaction is shown in Fig. 1. As the tine vibrates, it moves back and forth in reaction to forces 1 and 2. However, when force 3 is imposed by turning the handle, the tine moves in reaction to the vector sum first of forces 1 and 3, and then 2 and 3. The resultants (4 and 5) shown in Fig. 1, produce the twisting motions shown in Fig. 2. A sensor detects the twisting motion, whose amplitude is a function of the rate of turn of the handle, and whose phase (in comparison with the phase of the fork vibration) depends on the direction of turn.

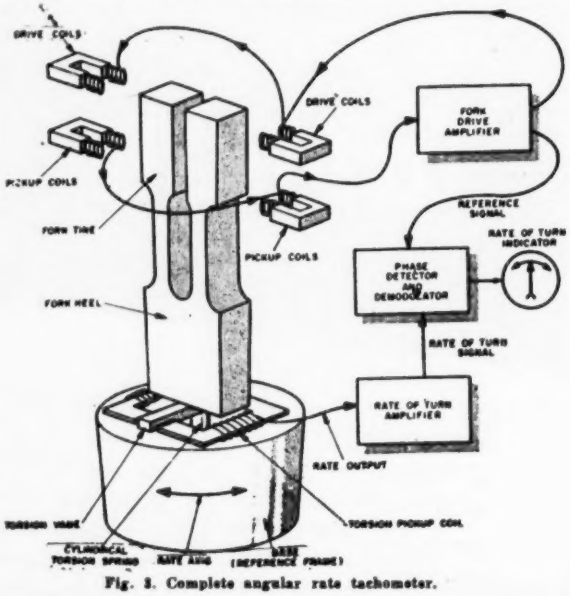


Fig. 3. Complete angular rate tachometer.

The components of the complete angular rate tachometer are shown in Fig. 3. The pickup coils detect the motion of the tine; another pickup coil detects the motion of the torsion vane. The output of the latter is amplified and then compared with that of the former in a phase detector whose output is delivered to the rate-of-turn indicator.

The fundamental principle of the vibratory gyroscope, discovered at Sperry, indicates a promising range of applications. Its development, however, is still in the experimental stage and it may be some time before it is ready for production. Two articles on the principles of the "Gyrotron" are in the Vol. 12, No. 11 issue of the *Aeronautical Engineering Review*.

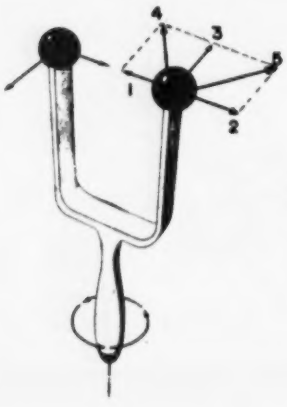


Fig. 1. Force vectors acting on tine.

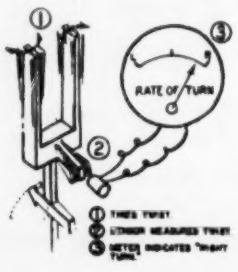


Fig. 2. Twisting motion of tine causes sensor to vibrate.

Xeroradiography

CLEVELAND, OHIO—The first prototype unit of the newest X-ray development—Xeroradiography—is being

2 new Autronic packages help you control and/or record temperatures instantly . . . accurately . . . inexpensively

No matter what the process . . . no matter how stringent the control requirements—if it can be done with a pneumatic or electro-mechanical system, it can be done better, faster, easier and generally at less cost with one of the two new *Autronic* Packages.

Since the *Autronic* System is *all-electronic*, it eliminates transmission lags . . . places no restriction on location of components. Other plus features are flexibility for multiple control systems . . . interchangeability of components without recalibration . . . elimination of expensive-to-install, troublesome air lines.

So if temperature control and/or recording is your problem solve it the *all-electronic* way—with a Swartwout *Autronic* Package. Literature and prices on request.

A-7073

Swartwout *Autronic* CONTROL SYSTEM

THE SWARTWOUT COMPANY • 18511 EUCLID AVENUE • CLEVELAND 12 • OHIO

For more information circle **17** on inquiry card.

EPLAB

PYRHELIOMETER
For the Measurement of
SOLAR RADIATION

Eppley Pyrheliometers are used for solar radiation measurements at ninety-eight weather stations in the continental United States, Canada, Alaska, Greenland, Iceland, Caribbean Sea, and the Pacific Ocean. Sixty-two of these stations are under the direction of the United States Weather Bureau.

The Eppley Pyrheliometer was adopted as standard equipment by the Weather Bureau after considerable experimentation. It was found to be the best instrument so far tested by the Bureau.

Used in conjunction with a suitable recorder, the Eppley Pyrheliometer will provide an accurate and reliable record of total solar and sky radiation on a horizontal surface.

Bulletin No. 2 on Request

THE EPPLEY LABORATORY, INC.

Scientific Instruments

2 Sheffield Ave.
Newport, Rhode Island U.S.A.

For more information circle **18** on inquiry card.

ON THE MARCH—CONTINUED

tested by Aluminum Company of America at its Cleveland Research Division. Alcoa is cooperating with General Electric's X-ray Department and with The Haloid Company in field evaluation of this unit for inspection of castings.

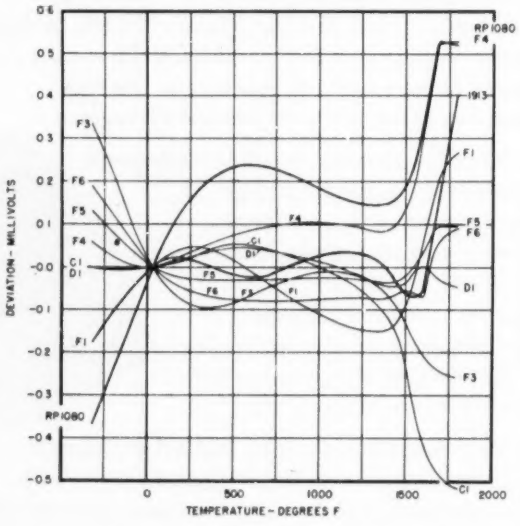
Xeroradiography uses static electricity to arrange a fine-grain powder on a specially coated aluminum plate, producing an image similar to that on an X-ray film.

The primary development involves the re-usable plate, which is used with the conventional X-ray tube and involves no new X-ray equipment. The need for a dark room to prepare the image is eliminated. A permanent record of the image on the plate can be made in a few seconds by photographic methods.

What promises to be the most significant aspect of Xeroradiography is its extreme speed, which should open the use of X-ray to many new metalworking firms and broaden its use in those now employing standard radiographic procedures.

Iron-Constantan Thermocouple Tables

WASHINGTON, D. C.—New reference tables for iron-constantan thermocouples, recently prepared by the National Bureau of Standards, constitute an important step toward uniformity in this field. Covering a range from minus 310 to plus 1600 deg. F.s the tables correspond more closely to the properties of commercially available thermocouples than do any of the other iron-constantan reference tables currently in use. The NBS tables are based on an investigation carried out by R. J. Corruccini, Henry Shenker, and other members of the Bureau staff at the request of the Scientific Apparatus Makers of America. They have been recommended by the SAMA for adoption as a tentative standard.

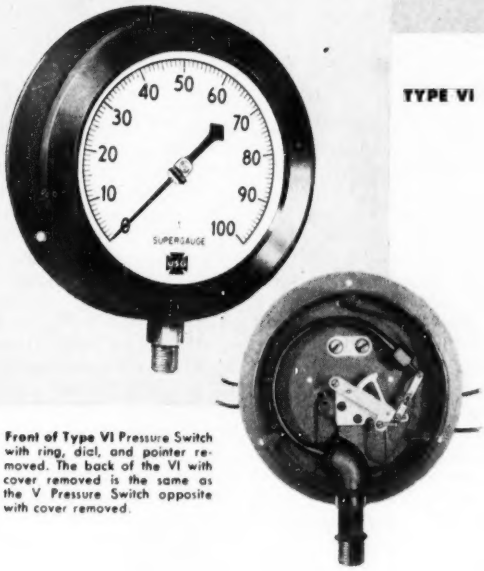


The figure shows deviations of the 1913 table, the RP 1080 table, and the various iron-constantan thermocouples studied by NBS, from the temperature-emf. relationship given in the new tables.

A number of widely diverse reference tables have been used for iron constantan thermocouples. In 1938 NBS derived the RP 1080 table[1], which represented the average behavior of the commercially available iron-constantan thermocouples. However, this table was not widely adopted because its use would have involved changing the scales of the pyrometers then in use. In 1948, SAMA, representing

PRESSURE SWITCHES

• What they are • How they work • Where you use them



Front of Type VI Pressure Switch with ring, dial, and pointer removed. The back of the VI with cover removed is the same as the V Pressure Switch opposite with cover removed.

Type V Pressure Switch with cover removed.

The USG Type V Pressure Switch consists essentially of a pair of micro-switches making or breaking contact in response to a pressure-sensitive element (bourdon spring).

Type VI has the same switch-operating pressure element as Type V but it has an additional bourdon spring connected to a pointer so that pressure can be read on a dial.

Pressure switches are used wherever a pressure warning signal must be given. Typical applications are: hydraulic pumps, hydraulic presses, die casting equipment, or guarding or controlling high or low tank pressures.

For information relating to your problem, call the United States Gauge office in your city or get in touch with us at Sellersville, United States Gauge, Division of American Machine and Metals, Inc., Sellersville, Pa.

CONSTRUCTION

TYPE V	**Case:**	Cast-iron case, back flange mounting, black crackle finish.
	Size:	4½" case only
	Bourdon Tube:	Beryllium copper or stainless steel
	Pressure Connection:	Lower only: ¼" male N.P.T. up to 1000 lbs. pressure; ½" male N.P.T. for 1000 lbs. and over.
	Electrical Connection:	½" female pipe conduit.
	Pressure Ranges:	Up to 10,000 p.s.i., vacuum to 30".
	Micro-switches:	High and low; rated 10 amps., 110 A.C., both fully adjustable over entire range of gauge.
	Switching Differential:	3%. Switches are not affected by overpressure.
TYPE VI		Same case construction, micro-switches, switch-operating elements, switching differential, pressure connections, electrical connections, and pressure ranges as Type V.
		Case has dividing wall between the separate bourdon spring systems for operating the pointer and the micro-switches.
	Dial Sizes:	4½" and 6"
	Accuracy of Indications:	½ of 1% of the scale range.

Quality Gauges Engineered for Enduring Accuracy UNITED STATES GAUGE

PRODUCTS OF UNITED STATES GAUGE... Absolute Pressure Gauges • Aircraft Instruments • Air Volume Controls • Altitude Gauges • Boiler Gauges Chemical Gauges • Mercury, Gas, and Vapor Dial Thermometers • Glass Tube and Industrial Thermometers • Flow Meters • Inspectors' Test Gauges Precision Laboratory Test Gauges • Marine, Ship and Air-Brake Gauges • Voltmeters • Ammeters • Welding Gauges.

OTHER DIVISIONS OF AMERICAN MACHINE AND METALS, INC. AT SELLERSVILLE, PA.: GOTHAM INSTRUMENTS, AND AUTOBAR SYSTEMS

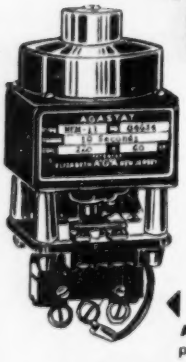
For more information circle **19** on inquiry card.

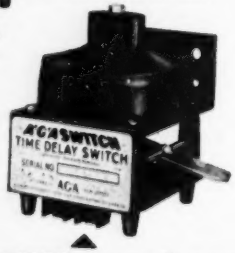
SUMMING UP

. . . here are the new products introduced by AGA in the past four months. Watch for the most important advance in 50 years of pneumatic timing —to be announced by AGA in the near future.

AGASTAT Model SF Compact, hermetically sealed time delay relay.

AGASTAT Model NET For the introduction either of a series of time delays or a momentary impulse into electrical circuits.





AGASWITCH For manually or mechanically introducing time delays into electrical circuits.

AGASTAT Model NEH For remote push-button control of time delays.

WRITE for details on these pneumatically timed solenoid-actuated time delay relays. Ask our application engineers for help with your timing problem. Address Dept. A12-19.

AGA DIVISION

Elastic Stop Nut Corporation of America

1027 Newark Avenue, Elizabeth, New Jersey

Pioneers in pneumatic timing.

For more information circle **20** on inquiry card.

ON THE MARCH—CONTINUED

several of the pyrometer manufacturers, adopted the temperature-emf relation known as the 1913 (L and N) table[2] as a tentative standard for iron-constantan thermocouples over the range from 32 to 1400 deg. F. However, experience has shown that it has not been possible to produce a thermocouple from present-day commercial iron that will correspond precisely to the 1913 table.

The SAMA therefore requested the National Bureau of Standards to derive a reference table that would be as close as possible to the 1913 table yet would be free from defects. Each member firm of the SAMA that supplies iron-constantan thermocouples was invited to submit sample thermocouples for investigation at NBS.

As a result of the NBS investigation, the SAMA has recommended adoption of the temperature-emf relationship of one of the thermocouples studied as a standard to replace the 1913 table. Users and suppliers of thermocouples based on the 1913 table are favorable to the adoption of the NBS relationship, which is similar to the 1913 table. However, users of solely RP 1080-type thermocouples indicate that it is not practicable for them to change to the proposed SAMA standard.

Thus it appears that at least two standards, the SAMA table and the RP 1080 table, will coexist in the immediate future. Most commercial production of iron-constantan will probably be based on the SAMA table. On the other hand, one of the principal fields in which the RP 1080 table is dominant—namely, piston-engined military aircraft—is declining in importance.

Tables giving the new temperature-emf. relationship for both Fahrenheit and Centigrade scales have been published by NBS. See Modified 1913 reference tables for iron-constantan thermocouples, by Robert J. Corruccini and Henry Shenker, J. Research NBS 50, 229 (1953) RP 2415.

[1]Reference tables for iron-constantan and copper-constantan thermocouples, William F. Roeser and Andrew I. Dahl, J. Research NBS 20, 337 (1938) RP 1080.

[2]This table, sometimes called the Leeds and Northrup table, is identical with the tables given in International Critical Tables 1, 59 (1926) and in Tech. Pap. BS 14, 306 (1920-21) T170, Table IV, Col. L.

[3]Calibration of thermocouples at low temperatures, by Russell B. Scott, J. Research NBS 25, 459 (1940) RP 1339.

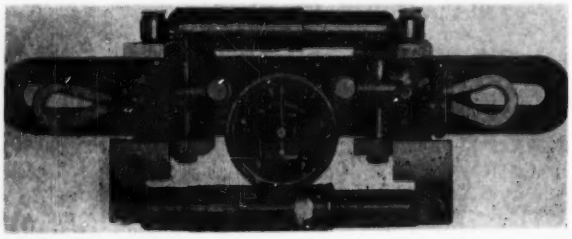
[4]Standardization of iron-constantan thermocouple tables, NBS Technical News Bulletin 34, 174 (December 1950).

M-H Course Schedule

PHILA., PA.—Schedules for industrial-instrument maintenance and repair courses for the first half of 1954 at Minneapolis-Honeywell Regulator Company's Philadelphia training school have been announced by the company's Industrial Division. The division again listed a 14-week comprehensive class which it offered for the first time last year. The 14-week comprehensive course will be held from Feb. 15 to May 21. Two five-week courses will start Jan. 4 and April 26. Shorter courses will start Feb. 15, March 8, April 5, and June 7. The address is Philadelphia 44, Pa.

Railroad Test

DENVER, COLO.—The Ruth Company of Denver faced a tough one in trying to measure the pulling power and stall point of an electric mining locomotive and a string



K & M introduced the molded diaphragm ...WHY?

Unlike many conventional control valve diaphragms, K & M contour molded diaphragms maintain a *constant effective area* throughout the entire range of valve stem travel. Control variations are transmitted to the K & M inner valve without distortion for more accurate, more reliable flow regulation. And, with less possibility of any binding and sticking whatsoever.

Furthermore, the effective area of the K & M contour molded diaphragm is particularly large. This greater area, combined with long stem travel, enables K & M Diaphragm Motors to provide virtually the highest "power factor" available. Thus, not only is the inner valve positioned more accurately, but sensitivity of response is also increased.

To assure long term service under the toughest operating conditions, all K & M diaphragms are molded of tough, inert neoprene and fabric reinforced.

In addition to contour molded diaphragms, K & M Control Valves incorporate other unique operating advantages, such as all steel topworks construction with open-yoke design, and the two-bolt patented continuous seal method for positive diaphragm casing closure.

WRITE FOR YOUR COPY of the new K & M Valve Engineering Data Catalog, Bulletin CV53.
NEW . . . Valve Size Slide Rule Calculator with LOW FLOW DATA. Available upon request.

KIELEY & MUELLER, INC. diaphragm control valves

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64 Genung Street
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Since 1879

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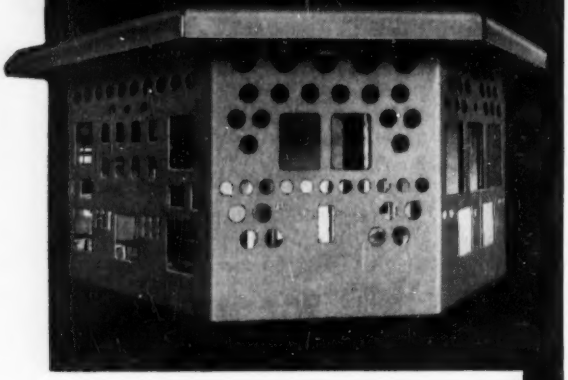
electrical enclosures by KIRK AND BLUM



Whether you need one simple cabinet, a pair of control desks or a thousand precisely manufactured weatherproof housings, call on KIRK & BLUM for quick service.

Complete facilities for fabrication of sheet steel, plate, light structurals, stainless, aluminum, monel or other alloys.

Join the long list of plants which depend on KIRK & BLUM for sheet metal and plate fabrication.

For complete information...literature on fabrication facilities and experience ...write to: The Kirk & Blum Mfg. Co., 3111 Forrer Street, Cincinnati 9, Ohio.

CONTRACT MANUFACTURING FACILITIES for

- Boiler, Turbine and Generator Control Panels
- Power Distribution and Control Panels
- Switch Gear Housings • Instrument Panels
- Cubicles • Electrical Enclosures • Machine Bases
- Transformer Enclosures • Control Desks
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- Air Ducts • Stacks • Casings • Hoppers

KIRK AND BLUM
METAL FABRICATION

For more information circle 22 on inquiry card.

ON THE MARCH —CONTINUED

of loaded cars in actual field tests—without having the instrument calibration destroyed by the severe shock loads. The problem was solved by affixing hydraulic shock absorbers to each side of a Dillon dynamometer. The assembly is hooked between the drawbar of the locomotive and the string of cars. The dynamometer was made by the W. C. Dillon Co., Van Nuys, Calif.

Timing the Sabre Jet

SALTON SEA, CALIF.—When North American's F-100 Super Sabre streaked to a new world's speed record at Salton Sea, Potter chronograph equipment measured the speed—767 miles per hour on one pass and 754.98-mph.

average. The official timing technique used an electronic counter chronograph in conjunction with a Speed Graphic Pacemaker camera with Polaroid Land backs.

Heart of the precision timing system was a standard Potter 100-kc. Chronograph actuated by specially designed panning cameras at the start and finish lines of the 3-kilometer course. The 100-kc. instrument used was capable of resolution to 10 microseconds and provided a precision of the order one part per million. Over-all system accuracy was 55 parts per million.

Industrial Research

CHICAGO, ILL.—A new 10-minute 16-mm. color-sound picture, "It's Only Beginning," telling the story of industrial research is now available on a free loan basis from the Scientific Apparatus Makers Association, 20 North Wacker Drive, Chicago 6, Ill.

First Private Reactor

RALEIGH, N. C.—Engineering students at North Carolina State College check operation of the college's nuclear reactor—the first constructed exclusively for peacetime atom development and the first to be privately owned. In

measures, records and controls viscosity instantly, continuously, automatically!

This unique electronic instrument—the Bendix Ultra-Viscoson—provides *instant*, *continuous* and *automatic* viscosity measurement of hundreds of fluid materials in any stage of processing. All you do to get an accurate viscosity check is look at the dial. And all you do to install it is insert the small, rugged probe—by means of threaded connections—in a pipeline, kettle, pressure vessel, fractionating tower or tank.

In addition to indicating viscosity, the Bendix Ultra-Viscoson can be connected directly to any standard recorder or recorder-controller to automatically record and control viscosity in continuous processes.

You'll realize substantial savings, too, with a Bendix Ultra-Viscoson on the job. It completely eliminates costly work stoppage, sample taking, lengthy laboratory analyses and human error. Find out how you can improve your operation with a Bendix Ultra-Viscoson. Write today for complete information.

Simple ... Flexible ... Reliable!

No moving parts • Hermetically sealed probe • Operates in temperatures up to 650°F. and pressures of 1000 p.s.i. (special units available for higher pressures) • Measures in milliseconds • Remote operation • Permanently installed probe • Easily combined with remote recorder and automatic controls • Multi-probe and automatic temperature compensating systems available

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CINCINNATI DIVISION OF
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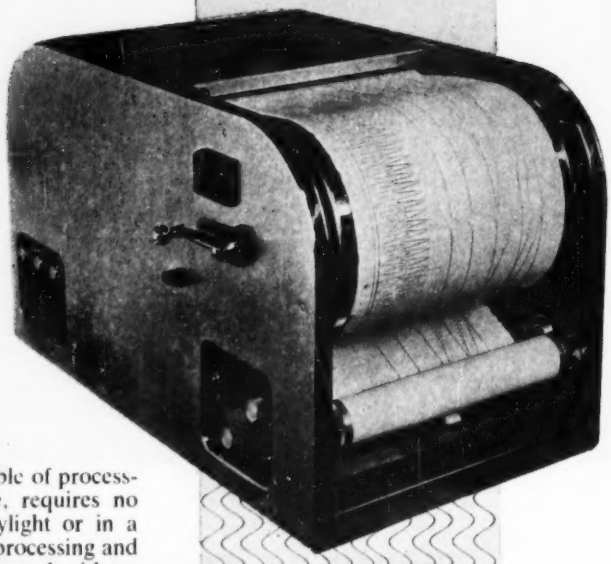
THE NAME Bendix AVIATION CORPORATION MILLIONS TRUST

Export Sales: Bendix International Division, 205 East 42nd St., New York 17, N. Y.

For more information circle **23** on inquiry card.

New, compact photo-record processor

for paper oscillograms and other rolled paper photo-records



THE TEST ENGINEER'S DILEMMA—how to develop and dry large quantities of test data on rolled sensitized paper—is solved by Consolidated's new Type 23-109 Oscillogram Processor. Built for operation at the actual testing site, this self-contained instrument, capable of processing records as rapidly as 15 feet per minute, requires no external water supply and can be used in daylight or in a normally illuminated room. Simplified loading, processing and unloading techniques permit operation by personnel without previous photo-lab experience. The Type 23-109 processor is compact, portable and fast, requiring only electric power for the paper-transport motor and the drying drum. Where the problem is to save time in processing voluminous test data on photo-record paper, CEC's new oscillogram processor is the practical answer. Write for Bulletin CEC 1537A-X8.

Consolidated

Reduces time lag between test and interpretation of data.

Requires no dark room for operation.

Built for testing-site use without external source of water.

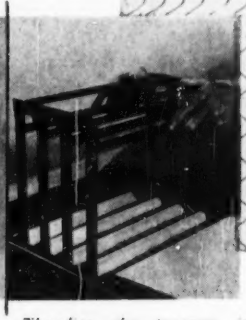
250 foot capacity for photo-record paper up to 12" widths.

Thermostatically controlled solution temperature.

Automatic squeegeeing for longer solution life.

Cumulative processed-footage indicator.

Loading of the magazine is easy. Processing of paper in varying widths to 12" is handled by simple, adjustable guides.



Threading the processor is simple. Insertion of the roller racks threads the short leader quickly and easily.

Consolidated Engineering

CORPORATION

300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service through **CEC INSTRUMENTS, INC.,** *a subsidiary with offices in: Pasadena, New York, Chicago, Washington, D. C., Philadelphia, Dallas.*

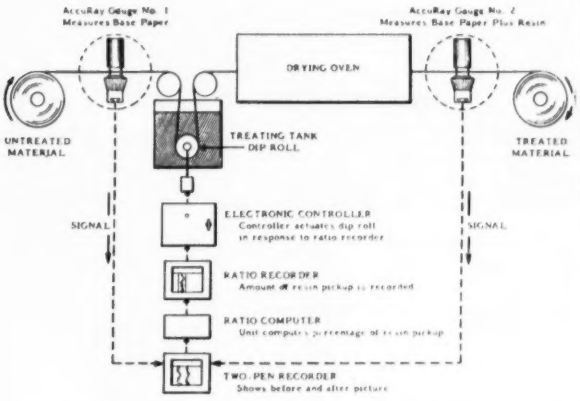
ANALYTICAL INSTRUMENTS FOR SCIENCE AND INDUSTRY

For more information circle **24** on inquiry card.

the background is a bank of electronic recording and controlling instruments specially developed by Minneapolis-Honeywell to regulate key aspects of the $120,000 low-power reactor. The reactor, part of a $620,000 facility, will primarily be used as part of the college's nuclear engineering curriculum. The one kilogram of U-285 to run the reactor is loaned by the A.E.C. At full output the reactor generates only 10 kilowatts of heat energy but supplies more atomic radiation than $200,000,000 worth of radium.

Radioactivity Controls Process

CINCINNATI, OHIO.—A combination of three recent control developments—nuclear energy, electronic computing, and automatic control—is providing the Formica Company of Cincinnati, Ohio, with improved control of a difficult



paper-impregnating process, controlling the amount of resin impregnated into various base papers on a continuous basis.

The installation, by Industrial Nucleonics Corporation, Columbus, Ohio, uses two "AccuRay" beta gages to continuously read the weight of the base paper before and after impregnation on a line that travels 100 feet per minute. These readings are analyzed by a computer and fed to automatic controller which adjusts the process machinery.

X-Ray Analysis

MT. VERNON, N. Y.—A new technique has been developed whereby quantitative measurements of sulphur in a specimen have been performed successfully, according to a recent announcement from the Research & Control Instruments Division, North American Philips Company, Inc., 750 South Fulton Avenue, Mount Vernon, N. Y.

Equipment consists of a standard Norelco Spectrograph with a new goniometer housing which allows the Geiger Counter to travel to 146 deg. (2θ) and permits use of helium instead of air in the X-ray path.

The work with sulphur was performed in connection with fuel oil problems. Analysis of results leads to the conclusion that the method has a probable sensitivity limit of 0.05 percent sulphur in oils.

Plane Checkout

PHILADELPHIA, PA.—Specially designed electronic recording instruments are installed in the nose of a Northrop

Why Corning High-Temperature Film-Type Resistors

are more rugged, more stable

The answer lies in the way we make them. The base material is a special heat-resistant glass that not only has excellent temperature and electrical characteristics but is tough enough to withstand real abuse.

The film material, too, is entirely new for resistors. Fired in at red heat, it becomes an integral part of the glass form. And it's so stable it can be cycled from near absolute zero to red heat with little effect in its electrical properties.

Silver bands are fired in for terminations that have low resistance and low noise characteristics. And silver plated end caps are expansion fitted over the silver terminations to give a silver-to-silver contact that is both electrically and mechanically sound.

Then, a silicone varnish is baked onto the resistor which completely reduces the risk of entrapped moisture, gives better protection against external moisture and humidity and abrasion. The unit can be rubbed with a nail file without materially affecting its electrical characteristics.

It all adds up to this. If you want a high-temperature resistor that's electrically stable, mechanically rugged, then investigate CORNING Type S Resistors. They can be operated at ambient temperatures up to 200°C. and at higher power levels to save space. The thin film construction and inherent stability provide excellent high-frequency characteristics. Normal resistance tolerance is 2%.

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Please send me information on:

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Name..... Title.....

Company.....

City..... Zone..... State.....

For more information circle **25** on inquiry card.

Two types of highly sensitive Meriam Well Type Manometers are designed to answer problems of critical indication for line operating pressures to 2,000 psi.

Either the Meriam M-180 PM High Pressure Manometer (vertical) or the Meriam M-182 Inclined Tube Manometer will dependably and accurately provide critical indication for calibration, flow, or differential pressure.

These instruments are designed and manufactured by a closely knit organization with 40 years of experience in instruments for primary indication of pressure or flow of liquids and gases. Ask a Meriam Technical Representative or write us for catalog sheet M-180 PM.

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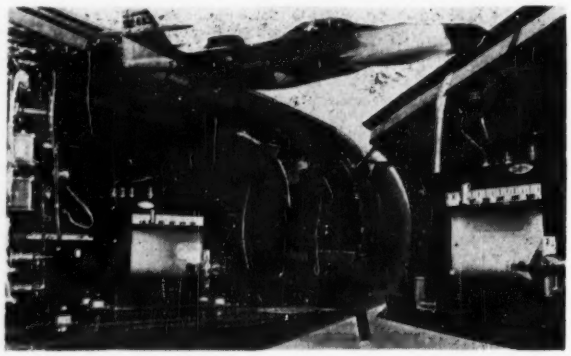
For more information circle **26** on inquiry card.

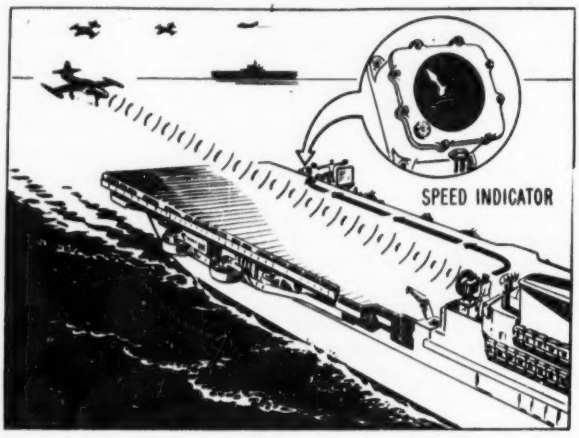
ON THE MARCH—CONTINUED



twin-jet Scorpion interceptor to automatically gather and record vital operating and performance data prior to the plane's checkout. The recording instruments, designed and engineered by Minneapolis-Honeywell's Industrial Division, can record as many as 144 primary elements in 3 to 4 minutes. The recorders also furnish accurate chart records that can be studied in detail upon completion of the test flight.

Landing-speed Radar

WALTHAM, MASS.—A new radar speed-measuring equipment, developed by Raytheon Manufacturing Company of Waltham 54, Mass., now safeguards the lives of Navy jet pilots and the complex and costly aircraft they fly.



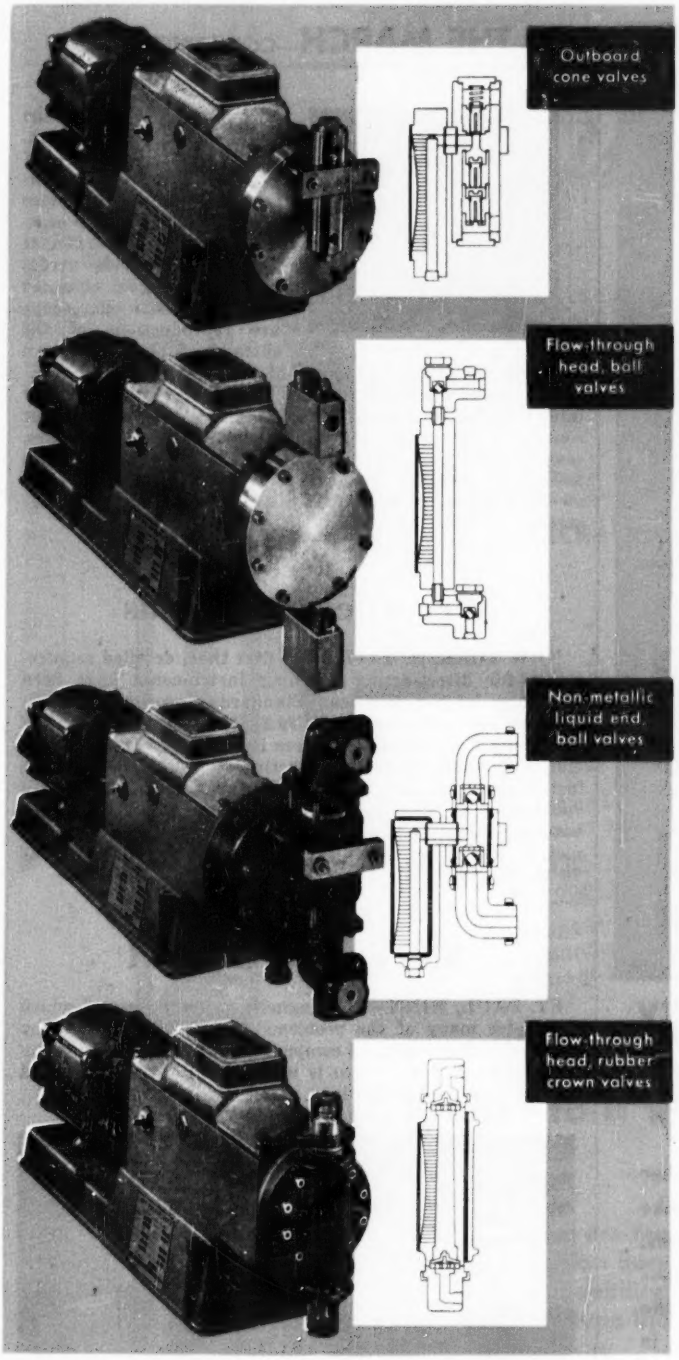
Radar waves are kept trained on the jet plane as it comes in for a landing on carrier's deck. The "echoes" from the plane are picked up by the antenna and serve as the basis for the new speed indicator to compute plane's true air speed. This information is relayed by cable to the dial at the feet of the landing signal officer. The LSO can now guide jets to safer landings.

Emission Microscope

MT. VERNON, N. Y.—A new Norelco emission microscope, companion to the company's EM-75 and EM-100 electron microscopes, is under development and will soon be shown publicly, it was announced today by the Research & Control Instruments Division, North American Philips Company, Inc., 750 South Fulton Avenue, Mount Vernon, N. Y.

The new instrument will be designed especially for metallurgical studies of metals and various metal oxides during heating.

Most emission microscopes available now are restricted


Outboard cone valves
Flow-through head, ball valves
Non-metallic liquid end, ball valves
Flow-through head, rubber crown valves

4 VALVE CONSTRUCTIONS

TO CHOOSE FROM IN

Lapp PULSAFEEDER

PISTON-DIAPHRAGM CONTROLLED-VOLUME CHEMICAL PUMPS

No one valve design or construction is adequate to handle all types of materials which must be pumped in controlled volume. Experience indicates that flow characteristics of fluids are greatly influenced by viscosity, specific gravity, lubricity and temperature; solids in suspension require a special design, whereas low-viscosity, non-lubricating liquids present a wholly different valving problem. Lapp offers the Pulsafeeder in a variety of liquid-end designs, materials of construction, and valve assemblies—four of which are shown here. For your "special problem" in proportioned pumping of liquids, ask us for an engineering recommendation on the Pulsafeeder assembly specifically suited.

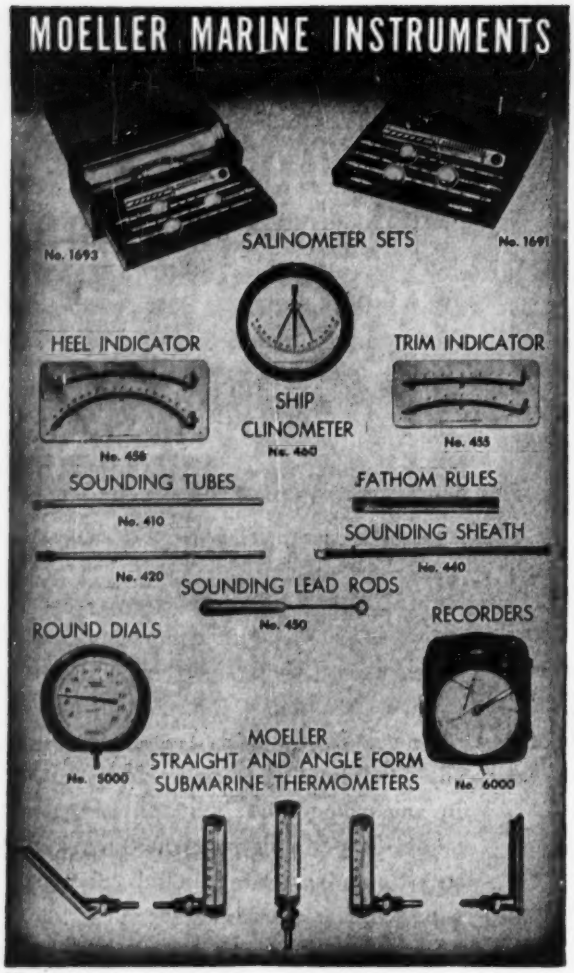
WRITE FOR BULLETIN 300 *with typical applications, flow charts, description and specifications of models of various capacities and constructions. Inquiry Data Sheet included from which we can make specific engineering recommendation for your processing requirement. Write Lapp Insulator Co., Inc., Process Equipment Div., 123 Wilson St., Le Roy, N.Y.*

POSITIVE DISPLACEMENT...AND NO STUFFING BOX!

Lapp Pulsafeeder is the combination piston-diaphragm pump for controlled-volume pumping of fluids. Reciprocating piston action provides positive displacement. But the piston pumps only an hydraulic medium, working against a diaphragm. A floating, balanced partition, the diaphragm isolates chemical being pumped from working pump parts—eliminates need for stuffing box or running seal. Pumping speed is constant; variable flow results from variation in piston-stroke length—controlled by hand-wheel, or, in Auto-Pneumatic models, by instrument air pressure responding to any instrument-measurable processing variable.

Lapp

For more information circle **27** on inquiry card.



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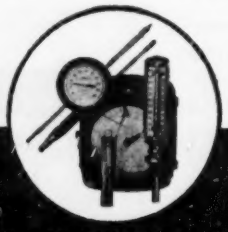

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For more information circle **28** on inquiry card.

ON THE MARCH—CONTINUED

to specimens which can be heated to include emission. Other specimens, capable of withstanding heavy bombardment are useable since they can be induced to scatter electrons of sufficient number to provide useful images. Images obtained with an emission microscope are reproductions of the surface of the specimen (cathode) which is the source of the electrons.

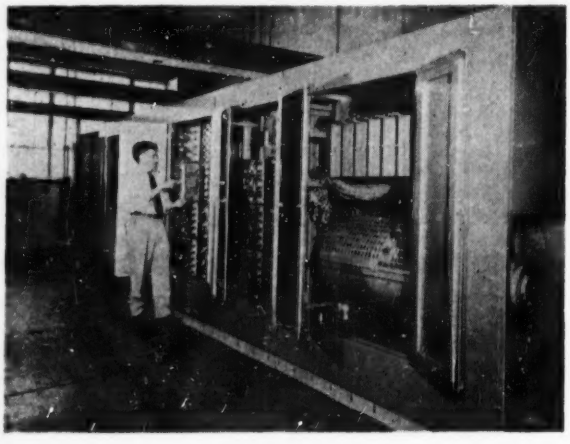
The emission head of the new Philips unit will have four inter-changeable filaments heated from a direct current source. It will provide for specimen activation with barium, cesium, strontium and other elements. Magnifications to 3000 diameters will be attainable; the supply will deliver 60 kilowatts to provide resolution better than 500 Angstroms.

Recorder Standards

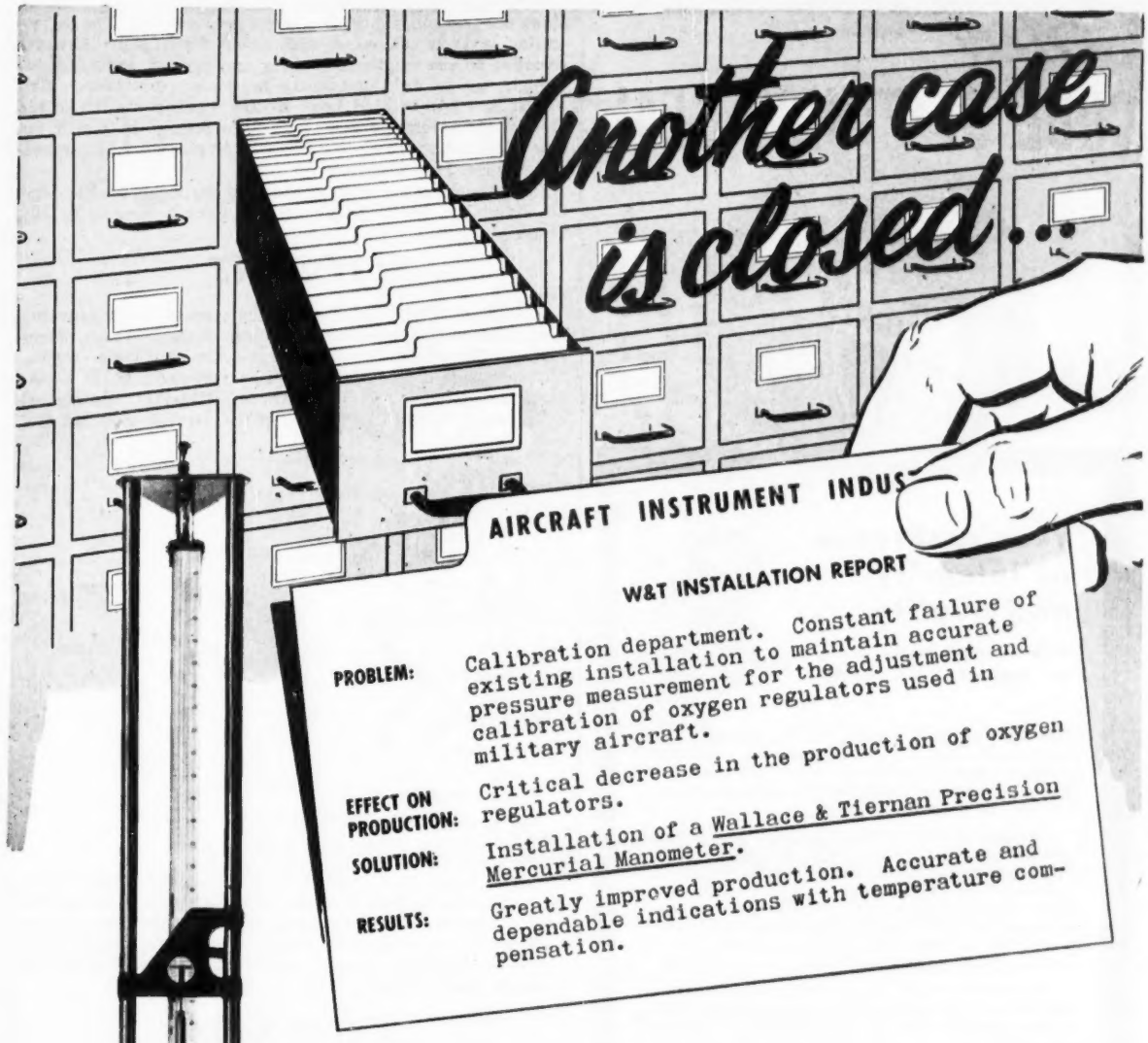
NEW YORK, N. Y.—For the first time, detailed requirements for direct-acting-recording instruments have been published, by the American Standards Association, in release of *American Standard C39.2, Direct-Acting Electrical Recording Instruments.* It covers leakage current, accuracy, and performance of all direct-acting recording instruments, including direct-current milliammeters, ammeters, millivoltmeters, voltmeters, and alternating-current ammeters, voltmeters, wattmeters, power-factor meters and frequency meters. The American Standards Association is located at 70 E. 45th St., New York, N. Y.

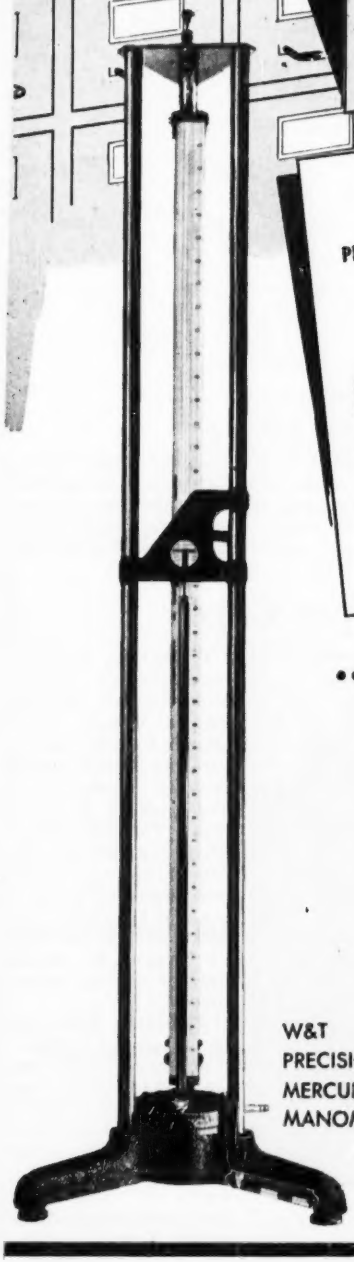
Air Traffic Control

ST. PAUL, MINN.—A "magnetic memory system" which may solve many of the problems of air traffic control by electronically storing and comparing flight plans of as many as 2,000 airplanes at once is being developed for the Civil Aeronautics Administration.



The new Flight Plan Storage unit includes a drum (shown in the right foreground) on which magnetic marks are made on the surface of a revolving cylinder within the drum. Information on departure times, fuel loads, destinations, routes, payloads and other data contained in airplane flight


Another case is closed...
AIRCRAFT INSTRUMENT INDUS
W&T INSTALLATION REPORT
PROBLEM: Calibration department. Constant failure of existing installation to maintain accurate pressure measurement for the adjustment and calibration of oxygen regulators used in military aircraft.
EFFECT ON PRODUCTION: Critical decrease in the production of oxygen regulators.
SOLUTION: Installation of a Wallace & Tiernan Precision Mercurial Manometer.
RESULTS: Greatly improved production. Accurate and dependable indications with temperature compensation.



W&T PRECISION MERCURIAL MANOMETER

...Thanks to a W&T Precision Instrument

FEATURES:

- **Scales are made with a precision dividing machine**
- **Precision bore tubing provides accuracy with interchangeability**
- **Float type indicator eliminates difficulty in reading meniscus**
- **Mercury-sealed valve permits evacuating the tube easily and quickly**

If you have a problem in the measurement or control of pressure, write today for additional information.

WALLACE & TIERNAN
PRODUCTS, INC.

ELECTRICAL MECHANISMS AND PRECISION INSTRUMENTS

Belleville 9, New Jersey • Represented in Principal Cities
In Canada, Wallace & Tiernan Products, Ltd. — Toronto

A-92

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New

CODE OF ETHICS SEAL

INDUSTRIAL GAS EQUIPMENT DIVISION
CODE OF ETHICS SIGNER
GAS APPLIANCE MANUFACTURERS ASSOCIATION

Your assurance of integrity and quality . . .

An announcement by the Industrial Gas Equipment Division, G.A.M.A.

"On April 15, 1953, members of the Industrial Gas Equipment Division of G.A.M.A. agreed on a program to assure you highest standards of safety, performance and durability in furnaces, ovens, boilers, melting equipment and other gas combustion assemblies.

"Obviously, it is impossible to develop laboratory tests and approvals, for protection purposes, as is the practice in other fields. Hence, each member has pledged himself to a *Code of Ethics* governing claims he shall make for his equipment, as well as care to be used in its design and construction. Each signer agrees scrupulously to avoid false or misleading statements with respect to grade, quality, design, construction and performance.

"Your assurance that *Code of Ethics* principles underlie manufacture of the equipment you buy is the *Signer's Seal*, reproduced above. Look for it as the symbol of integrity and quality!

"Let us send you a complimentary copy of the *Code of Ethics*, and a list of signers with products they manufacture."

H. C. Schaefer
Chairman

INDUSTRIAL GAS EQUIPMENT DIVISION
G. A. M. A.

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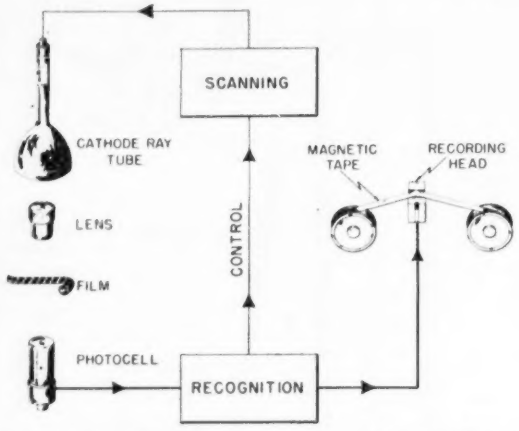
plans are transmitted to the system over teletype. The information is then compared with other flight plans already recorded on the magnetic surface, and revised, cancelled, or brought up to date, according to the circumstances. The results are transmitted back to the sending station, completing an automatic circuit of information in which no human operation is required; 2000 flight plans can be covered in less than half a second.

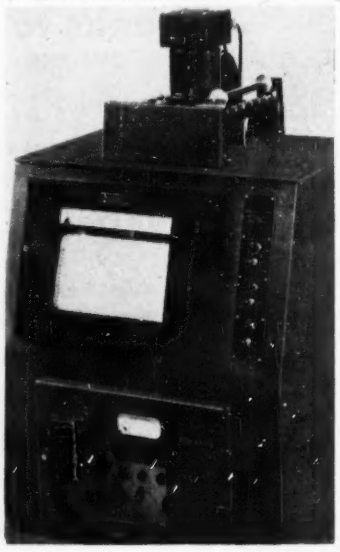
The new electronic system has been developed by Remington Rand Inc. at its Engineering Research Associates Division plant in St. Paul, Minn.

"FOSDIC"

WASHINGTON, D. C.—An instrument that provides rapid, automatic processing of information into a form suitable for direct input to large-scale electronic computers has been developed by M. L. Greenough, H. D. Cook, M. Martens and associates of the National Bureau of Standards. Named "FOSDIC" (Film Optical Sensing Device for Input to Computers), the machine reads marks on microfilmed copies of documents that have been marked with an ordinary pencil or pen, and then processes the information into electrical pulses which are recorded on magnetic tape for direct input to an electronic computer such as the Census Univac.



Paper Gage



LUFKIN, TEXAS.—Southland Paper Mills, Inc., of Lufkin, uses a unique paper scanning device incorporating a beta gage recently developed by Tracerlab of Boston, Mass. The Beta Gage Strip Scanner measures a profile of a 220-inch paper strip taken straight across the sheet; provides an easily interpreted measurement of web variations.

The chart drive, paper feed and radioactive source shutter are operated from the switch panel on front of the cabinet. The gage console is in the base of the pedestal because main interest is in the Minneapolis-Honeywell recorder trace.

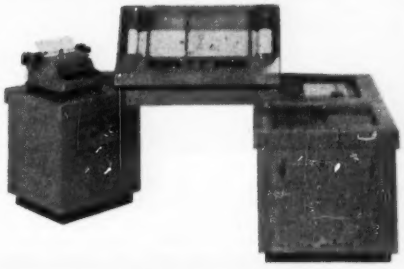
shake hands with Sitatãpatrãparãjitã!*

Imagine your data reduction staff with ten hands per time card...each one a gal like this popular goddess of Tibetan mythology. The money you'd save!...like your profits from a Benson-Lehner OSCAR (Oscillogram Analyzer and Recorder). For the OSCAR can do the work of many hands and eyes. The laborious tasks of reading, scaling, computing, plotting, tabulating, and card punching are transformed into a single push-button operation. The OSCAR converts raw data into final meaningful information for technical and management personnel. Faster...Cheaper... More Accurate than other methods. Write for further information.

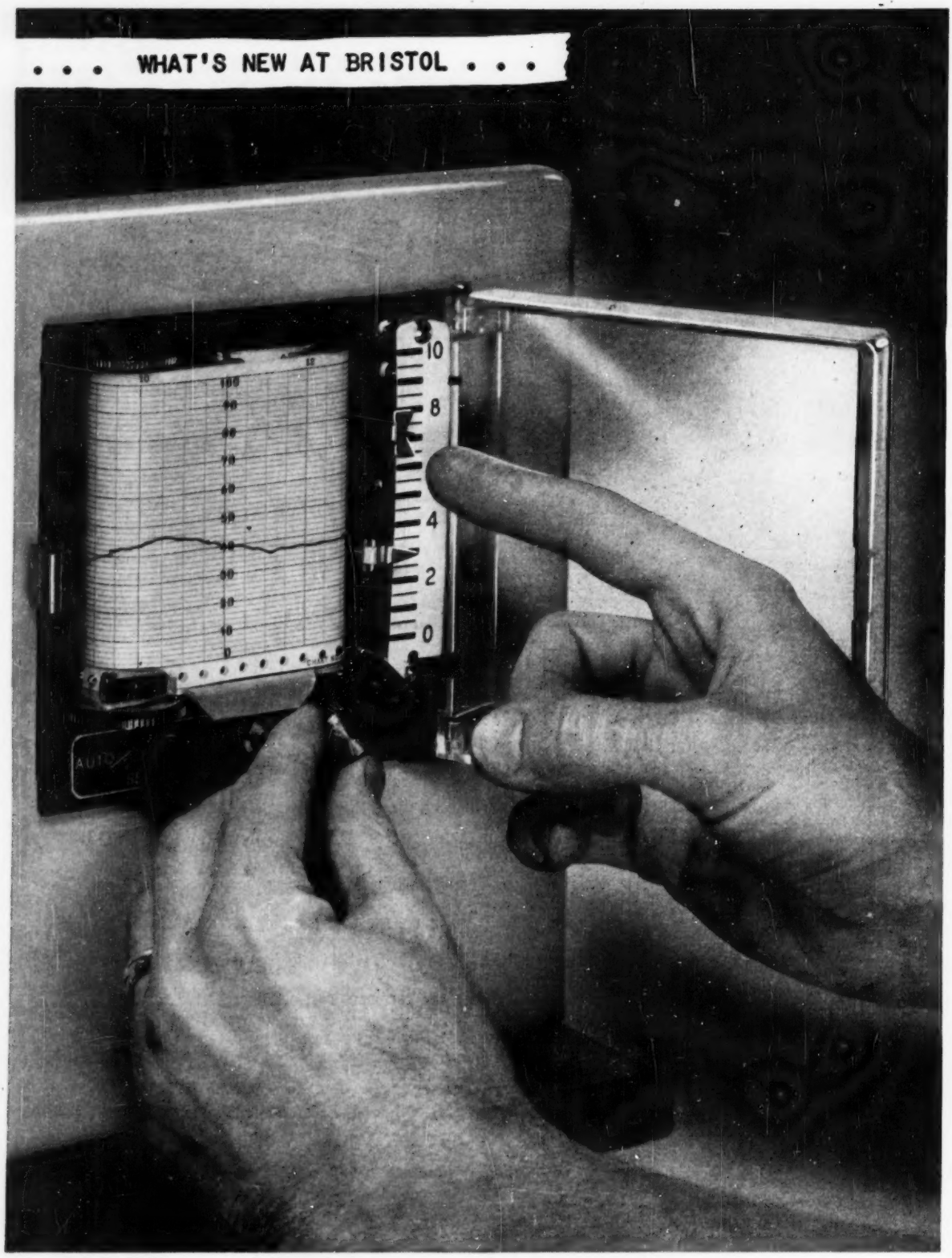
*A kindly goddess of Tibetan mythology equipped with no less than ten hands and three heads.

benson-lehner *corporation*

2340-E Sawtelle Boulevard, West Los Angeles 64, California



For more information circle **31** on inquiry card.



BRISTOL'S "HUMAN-ENGINEERED" METAGRAPHIC RECORDER, with its easy-to-read scale, high-visibility fluorescent pointers and shadow-proof door has earned a reputation as the "biggest miniature in the industry". There's no switching necessary to get a reading of the control valve position. The continuous valve-position indication, separate from set-point indication, gives continuous data on control valve position and process level. The high-precision, two-stage, no-drift set-point regulator has high-capacity (3 scfm) output for fast manual control in emergencies.

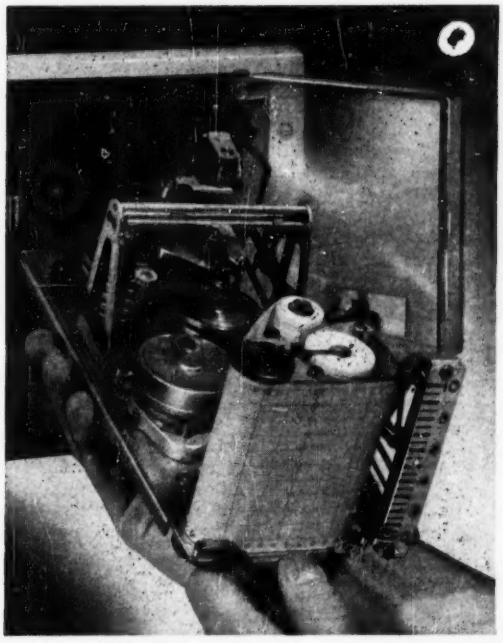
For more information circle **32** on inquiry card.

Instrument men call Bristol's METAGRAPHIC Recorder

"... the biggest little instrument in the industry"

Sounds contradictory, but it's true. Take a look at one of our new METAGRAPHICS mounted on a panel board alongside of other instruments. The Bristol unit stands out – seems bigger than the rest – although chances are it's actually smaller (5″x5½″). The answer is that the Bristol instruments have been *"human-engineered"*, making them easy to read, and clearly visible at greater distances.

To meet the increasing need for miniature instruments, we didn't simply scale down one of our larger recorders, we designed a completely new unit, creating a smaller instrument with all the advantages of the large one. In other words, the new METAGRAPHIC is a "big" little recorder.



TRUE PLUG-IN SERVICE is a big advantage to the operating man. If trouble is suspected in an instrument, the doubtful unit can be removed and a spare plugged in in a matter of seconds, with no interruption in the process operation, no loss of air, no loss of control.

"Human-engineered" METAGRAPHIC records pressure, temperature, vacuum, flow, differential pressure, and liquid level

Here are some of the advantages of the air-operated Metagraphic Recorders:

SIMPLICITY . . . fewer moving parts, fewer adjustments, and less service required. Range changes can be made in seconds.

CONTINUOUS VALVE-POSITION INDICATION . . . separate from set-point indication, gives continuous data on control valve position and level of process operation. No switching is necessary in order to get reading.

TRUE PLUG-IN SERVICE . . . provides great savings in installation costs. Cases can be ordered and installed before selecting range and type of control. Instruments can be plugged in later or interchanged at will. This adds up to a big advantage to the process design engineer – he doesn't need to make decisions during the design stage that can't be easily changed later.

CONTINUOUS OPERATION . . . complete unit can be retracted for inking pen, and for set-point and zero adjustment without disturbing record or control. Auto manual transfer is foolproof and "bumpless" with no disturbance of control valve position.

Get the whole story on the "human-engineered" METAGRAPHICS – how they can help you get more accurate measurements, faster and easier. Write us today. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.

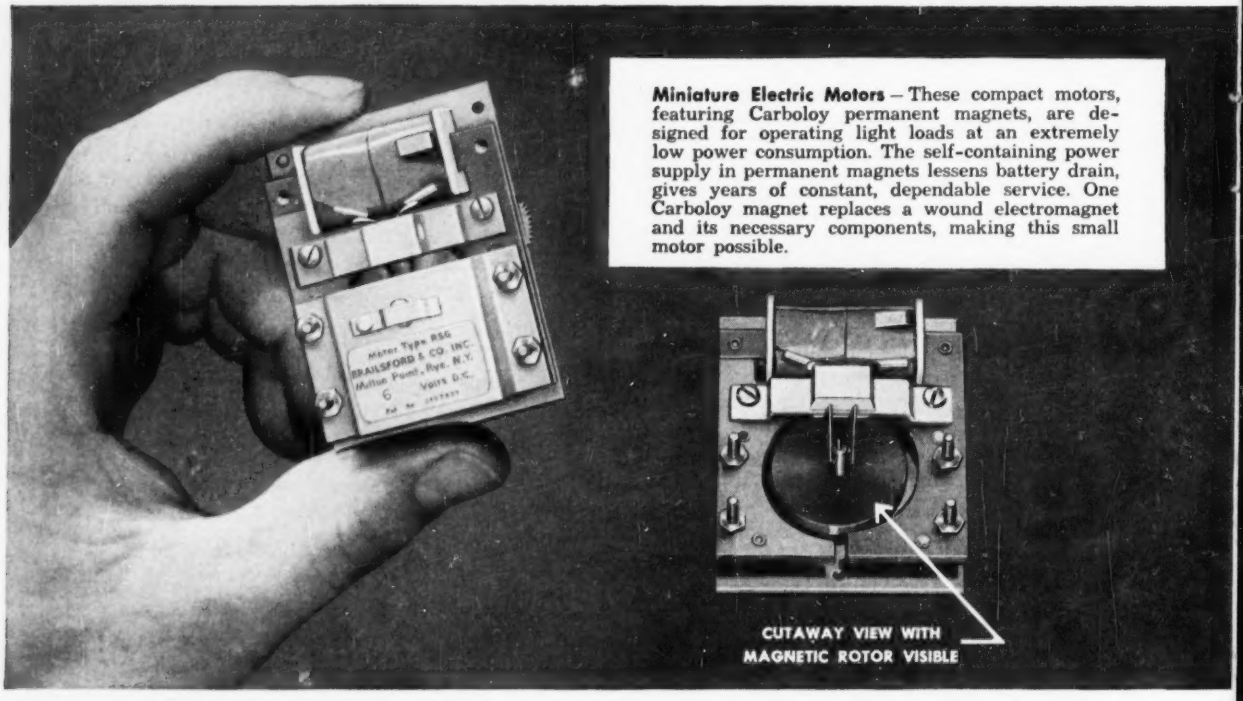
BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

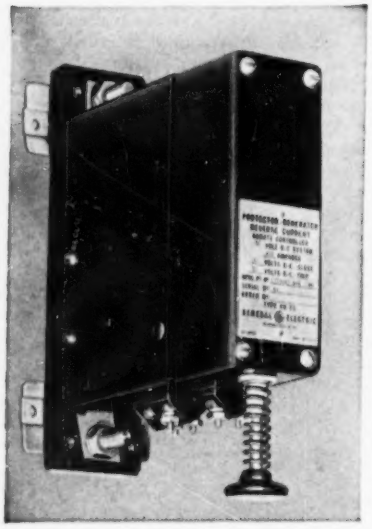
For more information circle **32** on inquiry card.

Why electrical products using weigh less, cost less,

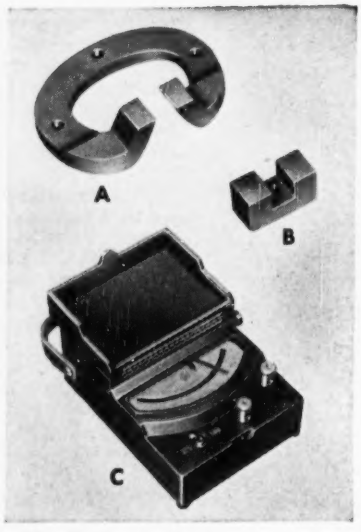


Miniature Electric Motors – These compact motors, featuring Carboloy permanent magnets, are designed for operating light loads at an extremely low power consumption. The self-containing power supply in permanent magnets lessens battery drain, gives years of constant, dependable service. One Carboloy magnet replaces a wound electromagnet and its necessary components, making this small motor possible.

CUTAWAY VIEW WITH MAGNETIC ROTOR VISIBLE



Circuit Breakers – Here, a Carboloy magnet assembly simplifies trip element. It eliminates a coil and polarizing connection . . . makes possible reverse-current tripping independent of system voltage. Breaker weighs less, costs less to build.



Instruments – Figure A is damping magnet once used in GE indicators. Figure B is tiny Carboloy magnet now used. It permits smaller indicator design (Fig. C), cuts materials and assembling costs . . . speeds up calibrations.

YOU GET ALL THESE BENEFITS IN CARBOLOY PERMANENT MAGNETS

- Cool–generate no heat
- Require no electrical energy
- Cost nothing to operate
- Eliminate coils, windings, wiring, etc.
- Need no maintenance–no coils to burn out, no slip rings to clean or replace, etc.
- Simplify mechanical assemblies–exert strong tractive force for holding, lifting and separating devices that eliminates component parts, makes product design and fabrication simple.
- Save space–great magnetic strength in small sizes
- Powerful–and power is constant
- Combine electrical and mechanical features–transform electrical energy into mechanical motion; mechanical motion into electrical energy
- No power failures ever
- Resist moisture–no coils to collect dampness
- Give uninterrupted operation
- Create savings–often eliminate costly, power-supplying parts
- Simple–no operating parts
- Reduce weight, product size
- Supply a permanent source of energy

For more information circle **33** on inquiry card.

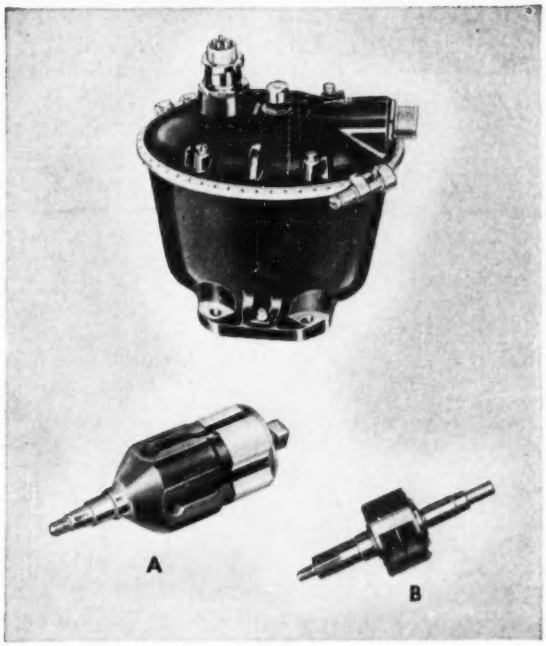
Carboloy permanent magnets work better

IF YOU manufacture any electrical device using an electromagnet, you will probably save money—by substituting, instead, a Carboloy permanent magnet.

For these magnets are permanent *sources* of energy that need no wires, coils or operating parts. Their power and small size let you simplify design, build more compact, finer-performing products, and save on material and assembly costs.

Check the magnet applications on these pages. Perhaps they'll suggest similar uses in your product. If so, contact a Carboloy magnet engineer. He'll welcome the chance to work with you on your design and application idea . . . at no charge, of course.

And the Carboloy name assures you of high-quality, uniform, high-energy permanent magnets in any size, shape; cast or sintered to your specifications. Send coupon for free Magnet Design Manual PM-101 and Standard Stock Catalog PM-100.



Magnetos – To save space and weight, Scintilla Magneto Division, Bendix Aviation Corporation, now makes aircraft magneto rotors from Carboloy permanent magnets. Figure A shows old-style rotor that weighs 4 lbs. 9 ozs. Figure B shows new rotating Carboloy permanent magnet weighing only 2 lbs. 4 ozs. – less than half as much as old-style rotor.

Hearing Aids – New all-magnetic, all-transistor "Radio-ear" hearing aid (made by E. A. Myers & Sons, Inc., Pittsburgh) uses Carboloy permanent magnets in *both* microphone and receiver. These magnets have eliminated hearing aid failure caused by severe heat and humidity encountered in normal use.

CARBOLOY
DEPARTMENT OF GENERAL ELECTRIC COMPANY
Plants at Detroit and Edmore, Michigan

"Carboloy" is the registered trademark for the products of the Carboloy Department of General Electric Company

MAIL COUPON TODAY

Carboloy Department of General Electric Company
11155 E. 8 Mile Blvd., Detroit 32, Michigan

Sirs:

Rush me, without cost or obligation, copies of Permanent Magnet Design Manual PM-101 and Standard Stock Catalog PM-100.

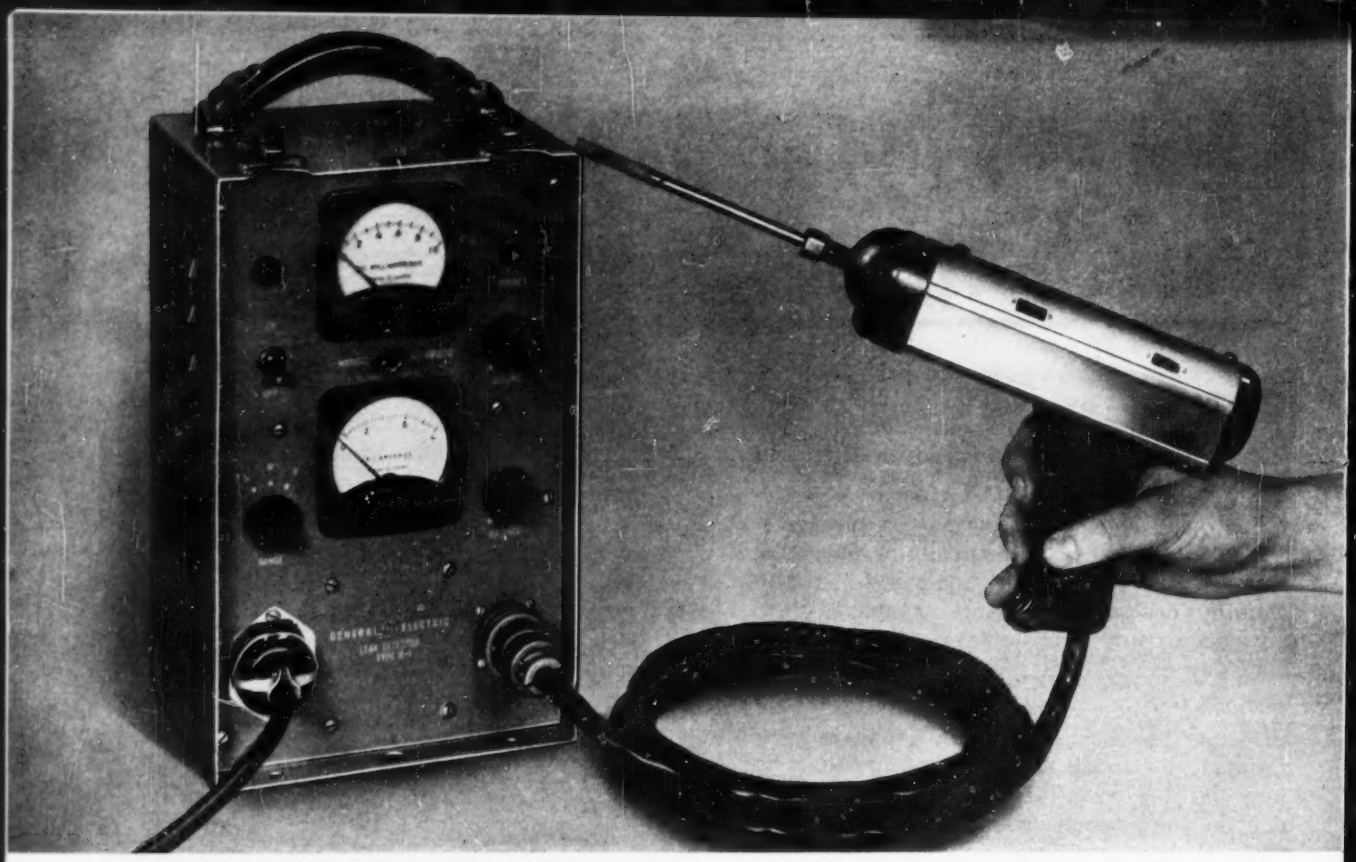
Name_____ Position_____

Company_____

Address_____

City_____ Zone____ State_____

For more information circle **33** on inquiry card.

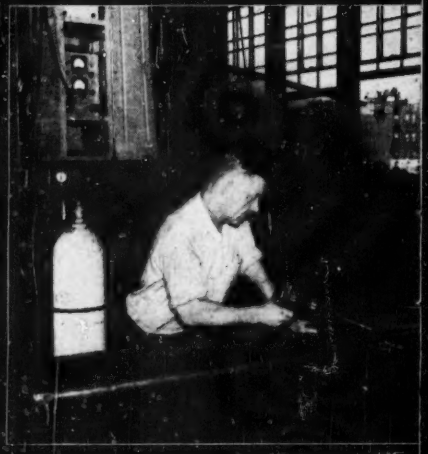


1 HIGHLY SENSITIVE, the G-E Type H-1 leak detector will detect a leak of 1/100 ounce of "Freon"* a year. A versatile instrument, the detector is designed to simplify the locating of leaks in any closed system containing "Freon," or some other halogen compound; or any system into which such a compound may be introduced as a tracer. Price including detector unit, control unit, and power-supply lead is $604.50.** For further information, mail coupon below.

G-E LEAK DETECTOR SERVES INDUSTRY AS

Here's How Others Are Benefiting by Using the New Type H-1 Leak Detector

IN ASSEMBLY-LINE TESTING of Lincoln automobile air-conditioners, the General Electric Type H-1 leak detector is used to quickly and sensitively "sniff" all vital connections under the chassis and hood.



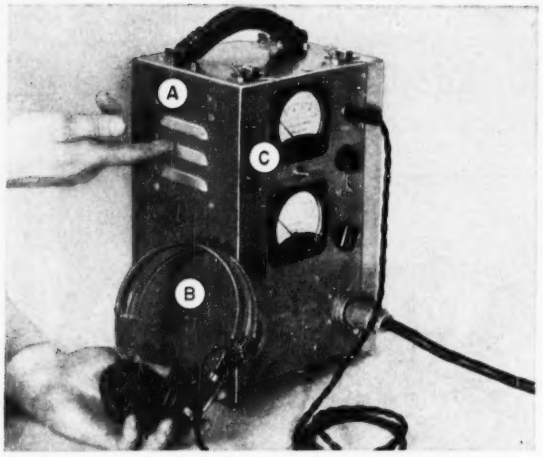
TO CUT REJECTS, the Angle Products Company, Cleveland, Ohio, checks their hydraulic oil and fuel tanks with the G-E leak detector. The new device has reduced the company's inspection time by 35%.

*Registered trade-mark, Kinetic Chemicals Div. of E. I. du Pont de Nemours & Co.
**Manufacturer's suggested retail price.

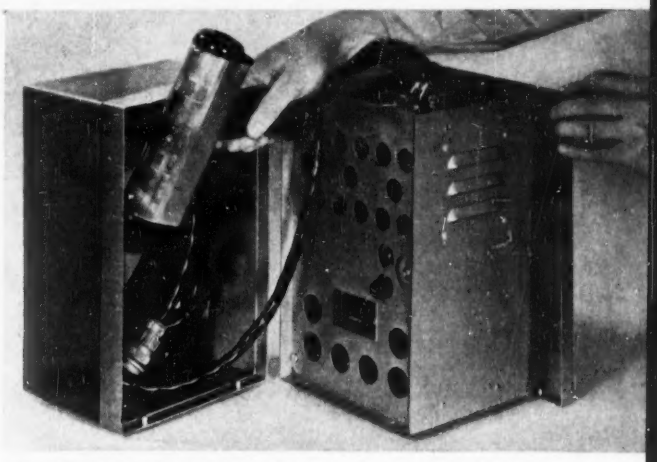
For more information circle 34 on inquiry card

New, Dependable G-E Leak Detector Simplifies Locating Hard-to-find Leaks

EASY TO OPERATE—READILY PORTABLE—EXTREMELY SENSITIVE



2 **LEAK INDICATIONS** by variable-pitch loudspeaker (A), earphones (B), and instrument dial (C) assure a true leak signal. Earphones, not supplied, may be purchased from your radio-supply dealer.



3 **READILY PORTABLE,** weighing only 24½ pounds, the unit may be carried to where it is needed. Leads and probe may be stored conveniently in rear of control cabinet. Sturdy carrying strap adds to the portability of the instrument.

IMPORTANT TESTING AND INSPECTION TOOL

SECTION B605-60
GENERAL ELECTRIC COMPANY
SCHENECTADY 5, N. Y.

Please send me a copy of your bulletin on the Type H-1 Leak Detector (GEC-233).

Name .....

Company .....

Street .....

City ..... Zone ..... State .....

FOR QUICK, ON-THE-SPOT TESTING for leaks in large power transformers and network protectors, the Georgia Power Company employs the new readily portable, easy-to-use G-E leak detector.

AN AID IN ASSURING FREEDOM FROM LEAKS, the G-E leak detector provides North American Aviation with a highly sensitive instrument for making extra-sensitive leak tests of aircraft fuel cells.

GENERAL ELECTRIC

For more information circle 34 on inquiry card.

PORTABLE

THRUST STANDS

for accurate, instantaneous,

Production Test and Flight Test both need accurate information about the performance of the plane under test, and particularly the net static thrust.

The builder's rating of engines under standard conditions, and the predicted performance of the assembly are important, but the actual performance, under ambient conditions, is vital to safe operation.

During the past five years, test after test has proven the accuracy, reliability and versatility of both fixed and portable thrust stands equipped with Hagan ThrusTorq units. The number and size of the Hagan ThrusTorq units used determine the capacity of a stand.

For example, the portable stand shown in the top photograph requires only stop pieces bolted to the apron. It will take any load up to 25,000 pounds of thrust. Each unit has its own supply of bottled nitrogen, used as a power source for the Hagan ThrusTorq. The stands can be set to accommodate the span of the landing gear of the plane under test.

The fixed type, shown in the center, uses Hagan ThrusTorq force measuring units. It is installed flush with the apron, and will test any plane with up to 45,000

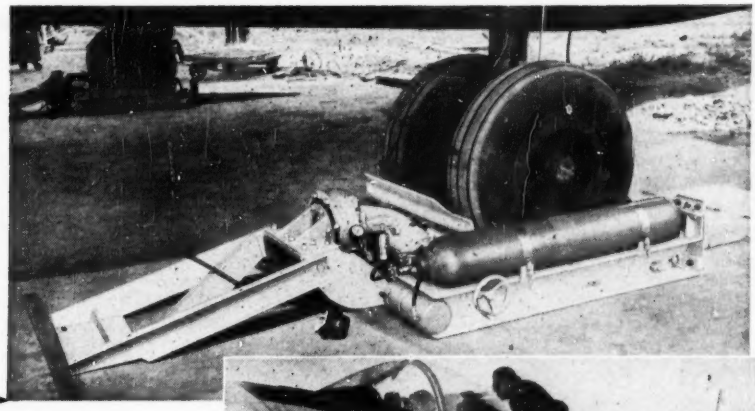
Hagan Corporation
AERONAUTICAL AND SPECIAL PRODUCTS DIVISION
HAGAN BUILDING, PITTSBURGH 30, PA.

•

CONTROL SYSTEMS FOR AUTOMOTIVE AND AERONAUTICAL TESTING FACILITIES
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
BOILER COMBUSTION CONTROL SYSTEMS

HAGAN
HALL
BUROMIN
CALGON

For more information circle **35** on inquiry card.

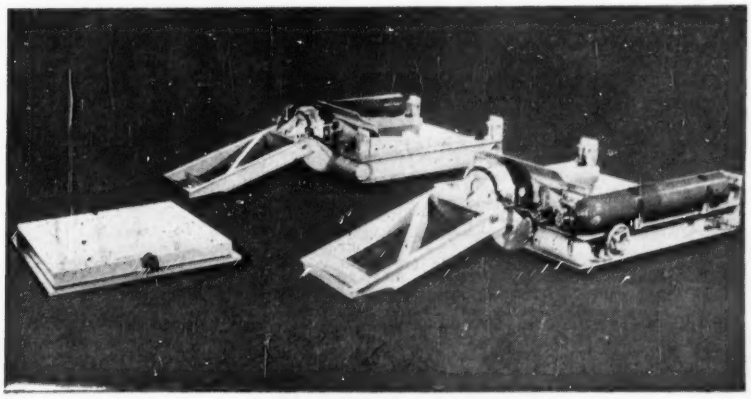


continuous readings of static thrust . . .

pounds thrust. It can be used with either compressed air or bottled nitrogen.

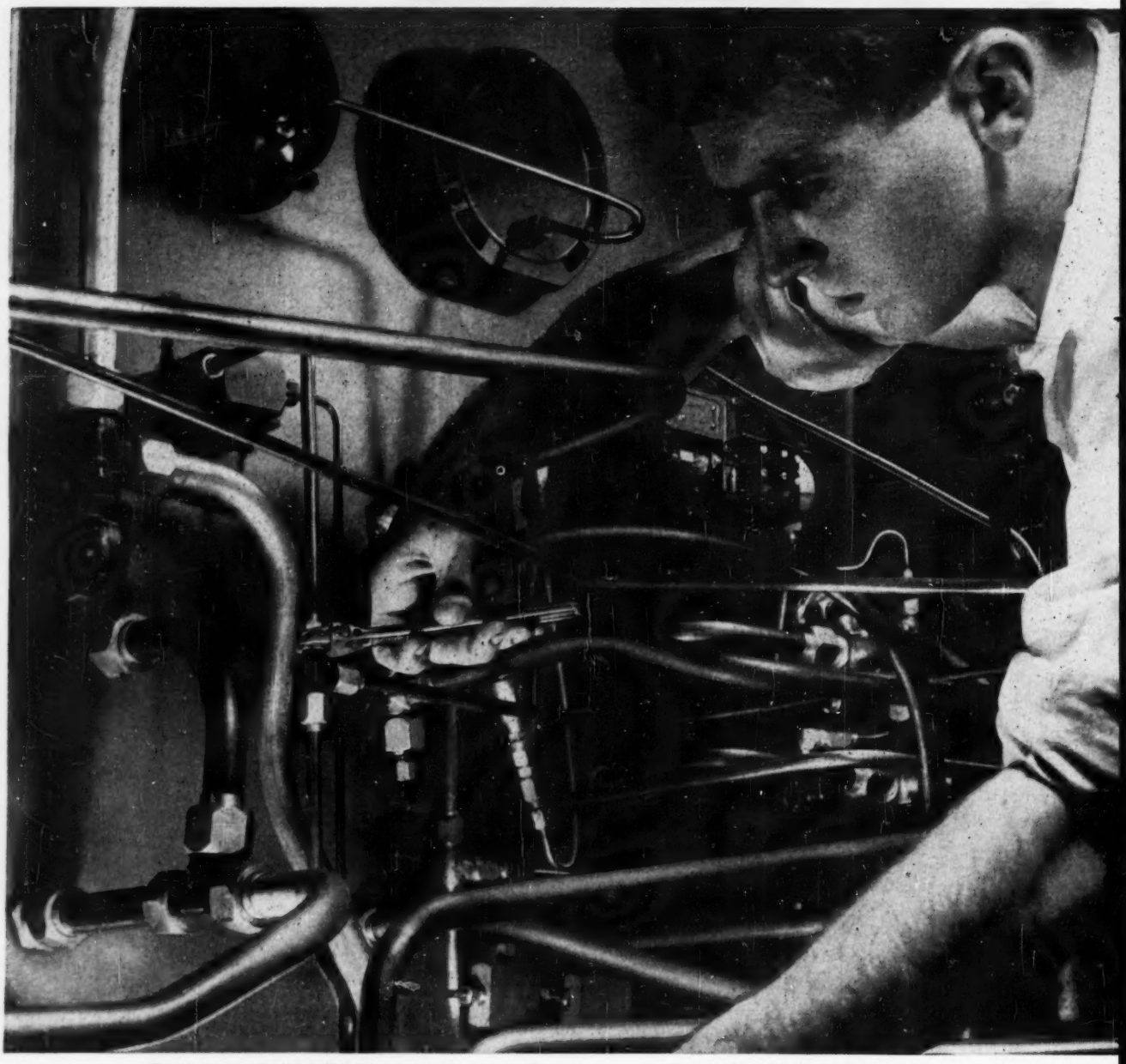
The Hagan ThrusTorq unit, shown below, is a pneumatically operated mechanism designed to produce a signal pressure directly proportional to the force imposed on it. It is fast, economical and clean, and is operable in any position. Signals produced are suitable for actuating indicators or recorders, either at the stand or remotely.

The Hagan ThrusTorq may also be used for rocket thrust measurement, jet engine thrust measurement, cradle dynamometer measurement of aircraft engines, and in many other applications.



Complete Portable Thrust Stand showing nose wheel unit and thrust measuring units in relative operating positions.

For more information circle 35 on inquiry card.



Easiest way to install tubing, even in cramped quarters, is to use Parker *Triple-lok* flare fittings. Assembly torque is so low that you need only a small wrench for fitting make-up. The self-aligning sleeve acts as a lock washer, supports the tube, and damps vibration. *Triple-lok* is absolutely leakproof even under high pressures and temperatures.

Jacksonville, Fla.	Florida Metals, Inc. 2937 Strickland St.	**Newport News, Va.**	Noland Company 27th St. & Virginia Ave.	**San Francisco 3, Cal.**	General Machinery & Supply Co. 1346 Folsom St.
Kansas City 16, Mo.	Metal Goods Corp. 1300 Burlington Ave.	**New York, N. Y.**	Nielsen Hydraulic Equipment, Inc. 5 Penn Place, Pelham Manor 65	**Seattle 9, Wash.**	Palmer Supply Co. 222 Westlake North
Knoxville 5, Tenn.	Leinart Engineering Co. 412 E. 5th Ave.	**New York 14, N. Y.**	Whitehead Metal Products Co. 303 W. 10th St.	**Shreveport, La.**	Standard Brass & Mfg. Co. 1557 Texas Ave.
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New Orleans 12, La.	Metal Goods Corp. 432 Julia St.	**Salt Lake City 4, Utah**	Pace-Turpin & Co. 726 South Third West	**Canada**	Railway & Power Engineering Corp., Ltd.

For more information circle **36** on inquiry card.

"Tube up and forget it" with leakproof Parker *Triple-lok* Fittings

Cramped and crowded, nobody likes to do this kind of a job over again. That's why trouble-free Parker *Triple-lok* fittings were used. Since this hydraulic test stand was completed, it has run over a billion impulse cycles at 3000 psi. without a single leak at any *Triple-lok* fitting.

These flare fittings are absolutely leakproof even under the severest conditions of vibration, high pressures and temperatures. Thousands of destruction tests prove that they will hold pressures that burst the tubing. And, they remain leakproof no matter how often you reassemble them!

Using *Triple-lok* fittings is also the easiest and fastest way to tube up your system even in close quarters. Flared tubing simplifies installation. For fitting make-up, you need only a small wrench because assembly torque is so low.

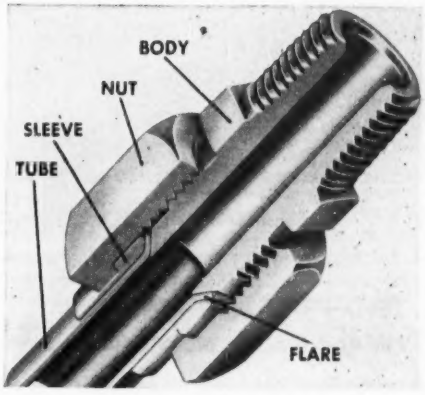
These fittings meet J.I.C. and S.A.E. standards plus specifications of the A.S.M.E. Code for Pressure Piping.

As a matter of fact, *Triple-lok* is the standard of industry. More *Triple-lok* fittings are used on industrial machinery than any other fitting.

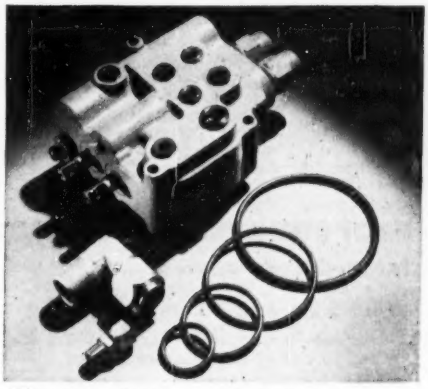
So, tube up and forget it. Use *Triple-lok* throughout your plant. Parker offers the widest range of shapes and sizes available . . . for tubing outside diameters from ⅛ through 2 inches. Ask your distributor for Catalog No. 4300.

TUBE AND HOSE FITTINGS DIVISION
The Parker Appliance Company
Section 404Q, 17325 Euclid Avenue, Cleveland 12, Ohio

Parker
Hydraulic and fluid system components



3-piece Triple-lok fittings are stocked in steel, stainless steel, brass, and aluminum alloy —available in other materials on special order.



What other Parker products interest you? Ferulok flareless fittings? Hydraulic control valves? O-rings? Write Parker for information.

CALL YOUR NEAREST DISTRIBUTOR FOR PARKER INDUSTRIAL FITTINGS

Akron 9, Ohio	B. W. Rogers Co. 850 South High St.
Baltimore 13, Md.	Carey Machinery & Supply Co. 3501 Brehms Lane
Baltimore 5, Md.	Whitehead Metal Products Co. 4300 E. Monument St.
Beaumont, Tex.	Standard Brass & Mfg. Co 705 Milam St.
Birmingham, Ala.	Mill & Textile Supply, Inc. 3128 Third Ave. South
Boston 15, Mass.	A. E. Borden Co., Inc. 176 Brookline Ave.
Bryson City, N. C.	Wallace Co. of N. C. P. O. Box 572
Buffalo 7, N. Y.	Whitehead Metal Products Co. 2128 Elmwood Ave.
Cambridge 39, Mass.	Whitehead Metal Products Co. 281 Albany St.
Cedar Rapids, Ia.	Globe Machinery & Supply Co. 309 8th Ave. S. E.
Charleston, W. Va.	Persingers, Inc. 514 Elizabeth St.
Charlotte 1, N. C.	Industrial Piping Supply Co. 1501 Dowd Rd.
Chicago 14, Ill.	Wallace Tube Co. 1300 Diversey Parkway
Cincinnati 29, Ohio	Williams & Co. 3231 Fredonia Ave.
Cleveland 14, Ohio	B. W. Rogers Co. 1279 East 12th
Cleveland 14, Ohio	Williams & Co. 3700 Perkins Ave.
Columbus 8, Ohio	Williams & Co. 851 Williams Ave.
Dallas 9, Tex.	Metal Goods Corp. 6211 Cedar Springs Rd.
Davenport, Ia.	Globe Machinery & Supply Co 410 E. Second St.
Dayton 10, Ohio	J. N. Fauver Co. 1534 Keystone Ave.
Denver 2, Colo.	Metal Goods Corp. 2425 Walnut St.
Des Moines 8, Ia.	Globe Machinery & Supply Co. East First & Court Ave.
Detroit 1, Mich.	J. N. Fauver Co. 49 West Hancock St.
Harrison, N. J.	Whitehead Metal Products Co. 1000 South Fourth Ave.
Houston 3, Tex.	Metal Goods Corp. 711 Milby St.
Houston 1, Tex.	Standard Brass & Mfg. Co. 2018 Franklin St.
Indianapolis, Ind.	Avels Sales & Engineering Co. 16 W. 22nd St.

For more information circle **36** on inquiry card.

A guide for selecting temperature control for top furnace performance

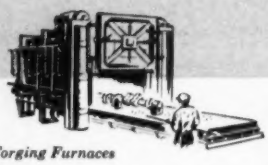
Today, industry's need for lower operating costs ...reduced maintenance...high quality of production ... has spot-lighted the importance of "tight" furnace control.

With closer specifications and higher control standards, more and more plants must pin down troublesome, costly departures from favorable heat-treating conditions.

To meet this demand, Leeds and Northrup has a complete line of matched temperature control systems available. You get equipment matched to your particular requirements. Each system comes to you as a "package" ready to handle the individual conditions created by your product, your production and your furnace.

There's an L&N control to match every industrial furnace

Annealing Furnaces



Forging Furnaces

TWO-POSITION CONTROL

For fuel-fired or electric furnaces

What it does:

Cuts heat input back to "low" when temperature exceeds control point . . . turns heat input on full when it falls below control point.

When to use it:

1. When changes in heat supply or changes in load are promptly "felt" by the temperature detector.

2. When alternate undershoot and overshoot will not damage product or process equipment, or slow down production.

3. When furnace pressure or fuel-air ratio *are not* controlled and the products of combustion *do not* form a protective atmosphere for the work.

PROPORTIONING-TYPE CONTROL

For fuel-fired furnaces

What it does:

Adjusts heat input by varying valve opening according to size of temperature change.

When to use it:

1. When there's a substantial time lag, before changes in heat supply or changes in load are "felt" by the temperature detector.

2. When load changes on continuous processes are both small and infrequent, and control point is rarely changed.

3. On batch process where operation is usually at the same temperature, and rapid recovery from upsets after loading is not important.

4. When furnace-pressure or fuel-air ratio *are* controlled, or the products of combustion *do* form a protective atmosphere for the work.

POSITION-ADJUSTING-TYPE CONTROL (P.A.T.)

For fuel-fired furnaces

What it does:

Adjusts heat input by varying valve opening according to size, duration and speed of temperature changes.

When to use it:

1. When there's a substantial time lag, before changes in heat supply or changes in load are "felt" by the temperature detector.

2. When load changes are both large and frequent and control point must be changed to suit various conditions.

3. When furnace design requires a continuously throttled flame.

4. When furnace-pressure or fuel-air ratio *are* controlled, or the products of combustion *do* form a protective atmosphere for the work.

5. Whenever overshoot is costly, hazardous or can cause damage to the product or heating equipment.

DURATION-ADJUSTING-TYPE CONTROL (D.A.T.)

For fuel-fired or electric furnaces

What it does:

Adjusts heat input by varying length of "heat on" time according to size, duration and speed of temperature changes.

When to use it:

1. When there's a substantial time lag, before changes in heat supply or changes in load are "felt" by the temperature detector.

2. When load changes are both large and frequent, and control point must be changed to suit various conditions.

3. When furnace design requires use of "on-off" operation of heat supply.

4. When furnace-pressure or fuel-air ratio *are not* controlled, and the products of combustion *do not* form a protective atmosphere for the work.

5. Whenever overshoot is costly, hazardous or can cause damage to the product or heating equipment.

***For complete information** regarding L & N Matched Temperature Control, write 4955 Stenton Ave., Phila. 44, Pa., or contact our nearest office.*

LEEDS NORTHRUP

instruments automatic controls • furnaces

Jrl Ad N-33(53b)

For more information circle **37** on inquiry card.

Editorial Comment

On Automation

THE word automation was coined by D. S. Harber, Vice President, Ford Motor Company, and by John Diebold, Harvard University, independently of each other and about at the same time. In the words of Diebold: "Automation is a new word denoting both automatic operation and the process of making things automatic."

Today this word (rather than the word Automaticity which we had been using for twenty-odd years) is a familiar one in industry and in publications of all types—technical and nontechnical. A brief review of some recent articles on the subject includes (1) Automatic Factories, *Fortune*, Oct., 1953, (2) Automatic Factories, *Wall Street Journal*, Sept. 25, 1953, (3) Automation, *Advanced Management*, Jan., 1953, (4) Automation—A New Word in Industry, *The Clevelander*, Oct., 1953, (5) Automation—and Other Technological Advances, American Management Association, 1953, (6) Automation In Industry—Its Meaning to Investors, Goodbody & Co. Monthly Letter, Oct., 1953, (7) Automation—The New Technology, *Harvard Business Review*, Nov.-Dec., 1953, (8) Factories Without Men, *The Nation*, Sept. 19, 1953, (9) Automatic Factories, *Mass Production*, Jan., 1953, etc., etc.

A review of these writings reveals that (1) business, financial, and technical magazines are now compelled to discuss the subject, (2) there is little in common between all the writings, (3) automation means only the instrumentation of machine-tool industries to some authors, (4) automation means only the use of computers to other authors, (5) almost all the authors reveal an unfamiliarity with the modern instrument industry—the industry which has produced the automation of the last decade, and which will develop the automation about which they write.

Automation means basically the use of automatic control by instruments. The application of automatic control in process industries has now reached an advanced stage, a stage that justifies the term "completely automatic." One or two operators now can operate a complete tar plant or a phenol-recovery unit; completely packaged gasoline-recovery plants now can be installed in remote locations for operation with no operators; thousands of miles of gas lines are monitored and kept in operation while completely unattended. The second industrial revolution, which began with the application of the first automatic control valve in a pipe line, is in a highly advanced stage in the process industries.

The machine-tool industries have similar problems associated with materials handling, dimensional gaging, and work and tool positioning. These problems must be solved before computers can be added to the control loop to make the "automatic factory" possible. Each new gaging instrument, each new inspection instrument, each new application helps solve the thousands of smaller problems that must precede the "automatic factory."

More complete automation of process industries now awaits more complete analysis of the process itself. Use of analytical instruments and powerful computers within the control loop awaits complete analysis of every variable and every conceivable situation within the loop.

This problem is somewhat analogous to the problem of weather forecasting—on which the safety of all air travel depends. The full ability of modern computers to analyze the motions of atmospheric disturbances is retarded—not by computer ability—but by lack of insufficient input data—there are not enough weather-reporting stations. (Of interest is the fact that one arm of the government is spending money to develop computers for weather forecasting while another arm of government—in the name of economy—is reducing the number of reporting stations.)

On page 135 of this issue, Glen Gallagher points out the modern frontiers of process instrumentation—analytical instruments, miniature graphic-type instrumentation, reponse speed, computers, and nucleonic instrumentation. Note the interplay of these frontiers, and how developments in any one field enhance developments in the others. Nucleonic tracer techniques are being used to analyze unit process operations so that the process can be designed to match the instrumentation; miniature instruments are making room for the complete automation center; response speed is being investigated at all points so that the high speed of modern computers can be used. No development in any one of the frontier fields is without effect on the others; the problems in each hold back the development of the others.

A new industrial revolution *is* well on its way. But in the vanguard of this movement are: You who make every new instrument for measurement and control, you who use them in your laboratories and plants, you who solve the thousands of instrument application problems which must precede the glamorous "automatic factory."

We believe that the best way to serve you and the field is to keep you informed of the American instrument industry, of all of its products, and of its step-by-step solutions. On page 114 of this issue is an exhaustive analysis of the American instrument industry. Between pages 40 and 103 are the several hundred new instruments that have come on the market in the last 30 days. The technical articles discuss specific instruments for specific purposes—the automation of nuclear reactors and soaking pits, the maintenance of electronic equipment and thermocouple circuits, the technique for development of photographic film, the frontiers of modern instrumentation.

This, we believe, is the practical way to advance automation—the second industrial revolution.

Hope you like it

THIS issue of *Instruments & Automation* brings you several innovations. A new feature—TRENDS—brings you interesting statements by authorities on what is happening in the field. Another new feature—BRIEFS—brings you basic principles as well as application details as reported in sources dealing with instruments and automation.

An important innovation is our new layout—designed to concentrate your articles into more compact and more readable form. Note that there is little article continuation. Most of the technical articles are complete within the full-page article section—as has been suggested by some readers. Note also the high percentage of editorial to advertising. Whereas many technical publications are 70% (or more) advertising, this issue contains nearly 50% editorial material. Of course, we should appreciate hearing from you as to how you like the new layout, the new features, and the expanded departments. We wish to serve you.

The Month's NEW INSTRUMENTS

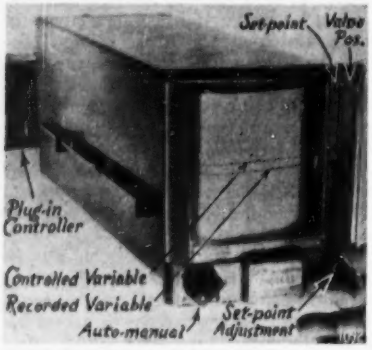
In this department we report each month new devices for measurement, inspection, testing, computing, metering and automatic control—in the form of concise technical descriptions.

FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 177

PROCESS CONTROL (and not otherwise classified)

Miniature Recorder or Recorder-controller

New "Ratographic" miniature recorder, capable of housing up to four simple pneumatic receivers, can record two variables and indicate two more, or record three variables and indicate



a fourth. To transform it into a recorder-controller with loading station, maker's standard field-mounted pneumatic controller may be plugged into back of chassis. Such a recorder-controller might record signals from (1) wild line and (2) controlled line and indicate (3) set-point signal and (4) valve signal. Instrument takes 6 x 6 in. of panel space; uses a 4-in. rectilinear strip chart, either electric or pneumatic drive. It can continue to function even while pulled forward for examination of internal mechanism. Pneumatic connections are self-sealing.—*Fischer & Porter Co., 13 Jacksonville Rd., Hatboro, Pa.*

For more information circle **201** on inquiry card.

Automatic Weigher-filler for Powders, etc.

New "Filamatic Model PB Powder Filling Machine" automatically dispenses powders, granular and crystalline materials in quantities from 10 mg. to 1000 mg. to 1-percent tolerance; is said to be the first of its type capable of dispensing micro quantities with such accuracy. Filling speed is variable from 500 to 1000 fills per hour. Machine contains no motor and no rotating parts. All parts which come in contact with filling medium may be removed for steam sterilizing. Entire apparatus is small enough to be placed under a hood in sterile room.—*National Instrument Co., 5005 Queensbury Ave., Baltimore 15, Md.*

For more information circle **202** on inquiry card.

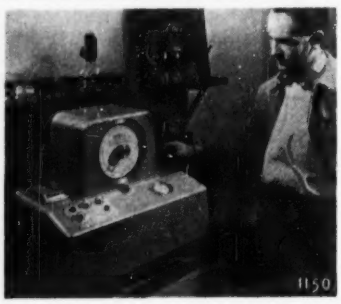
Sugar-process Recorder

New electronic recording instrument automatically and continuously computes sugar supersaturation. It measures degree of supersaturation by determining boiling temperature of sugar solution, absolute pressure of gases and vapors under which solution is boiling, and solution purity. Supersaturation is that point at which concentrated syrup, after boiling, contains more sugar in solution than could be dissolved by water at a given temperature. At this point, crystallization of sugar is started by introducing crystals. Computer-recorder permits control of seeding process, resulting in uniform sugar of high quality and obviating need for reprocessing.—*Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.*

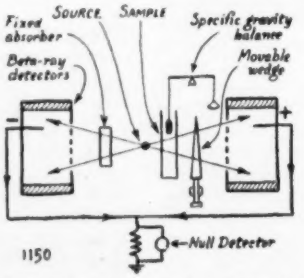
For more information circle **203** on inquiry card.

Hydrocarbon Analyzer

New "Beta Ray H/C Meter" (made under exclusive license by Standard Oil of Indiana) reduces time for de-



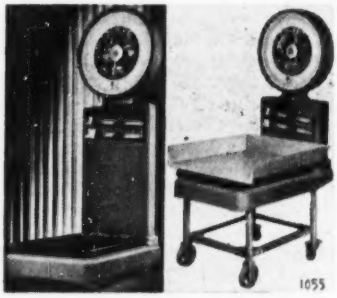
termination of hydrogen percentage in hydrocarbons from about four hours (by a skilled laboratory technician) to five minutes; is adapted for control in actual production operations. Individual determinations can be made with statistical probable error of 0.02 weight percent hydrogen, as against 0.05 for combustion-train method.—*Central Scientific Co., 1700 Irving Park Rd., Chicago, Ill.*



For more information circle **204** on inquiry card.

Industrial Scales

New Industrial Line comprises a full range of models from bench scales to heavy-duty motor-truck scales. One-piece sectors are featured in new full-floating, double-pendulum mechanism said to increase precision and strength and to eliminate the hand adjustments necessary in older assembly of several components. Indicating heads of new models can be installed to face in one of eight di-

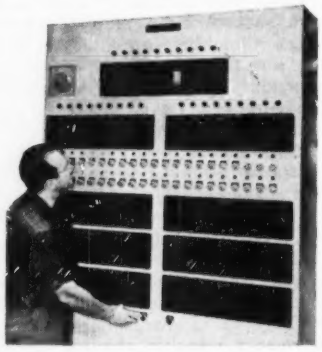


rections; or a scale can be ordered with a head to swivel fully through 360 deg. Improvements in portable model (shown at left) include a platform 18 percent larger, but with reduced over-all dimensions. Wheels are now within the base dimensions. Bench scale models (right) have platforms 31 percent larger but over-all widths and depths have been reduced. —*Toledo Scale Co., Telegraph Rd., Toledo 1, Ohio.*

For more information circle **205** on inquiry card.

Sequence Annunciator

New annunciator system automatically indicates sequence of "off-normal" alarms in applications where alarms are applied to closely interrelated variables—where process shuts down if any one variable goes "off-normal" and where, with conventional annunciators, it usually is difficult to



spot responsible variable. Sequence-indicating annunciators indicate this "first" variable by automatic lock-out of subsequent signals, or by causing first signal to be red and subsequent signals white. A pushbutton reset feature is also available which causes sequence indication to start over again. All contacts, relays and other moving parts are within hermetically-sealed plug-in units: additional signals can be added by adding plug-in units to common chassis. Systems, suitable for Class 1, Division 2 locations, are available in maker's standard backlighted nameplate cabinets providing from 3 to 48 signals.—*Panalarm Products, Inc., 6312 North Broadway, Chicago 40, Ill.*

For more information circle **206** on inquiry card.

Alarm and Normal Signal System

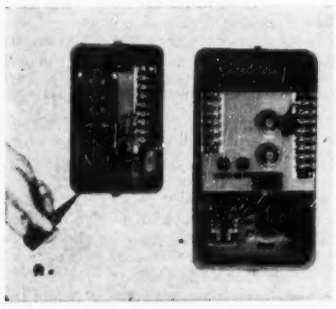
New "Model MLT" panel-mounted individual lamp annunciator has a back lighted illuminated nameplate fastened to front of small metal

cabinet. Cabinet contains lamps, relays, switches, etc. and is factory-wired for specified operation. Area of nameplate for "message" with toggle switch is 2¼x1 in. "Model MLP" without toggle switch provides 3x1 in. area for engraving, is for use in services requiring a common silencing and/or reset push-button. "MLT-200 Unit for #200 Service" (illustrated) signals abnormal and restored contact conditions: (1) Abnormal condition of contacts sounds audible signal and message is lighted with red and white bulbs; (2) operation of toggle switch silences audible signal and message is lighted in red only; (3) when contacts restore to normal, audible is sounded again and message is lighted in white; (4) operation of toggle switch to normal silences audible signal and darkens message.—*H. R. Kirkland Co., Morristown, N. J.*

For more information circle **207** on inquiry card.

Photoelectric-control Relays

Two new photoelectric relays feature improved circuit design and a full line of enclosures. One is rated at 450 operations per minute; the



QUIET!

One of the outstanding features of the

WELCH DUO-SEAL® PUMPS

beyond the production of better vacuums and longer life is that they are

QUIET RUNNING

Write for your copy of our new pump booklet, giving performance curves of all WELCH Pumps, including special vacuum techniques.

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DIVISION OF W. M. WELCH MANUFACTURING COMPANY
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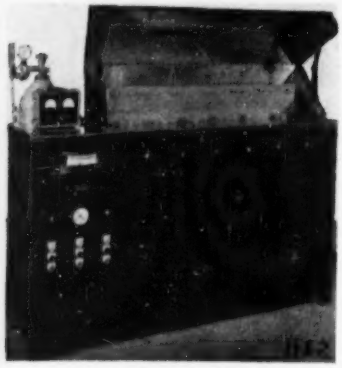
For more information circle **38** on inquiry card.

other is a high-sensitivity high-speed model rated at 600 operations per minute. Both may be used in many applications of counting, sorting, indicating and controlling. A choice of enclosures permits installation either indoors or outdoors, in high humidity atmospheres, or hazardous locations. —*General Electric Co., Schenectady 5, N. Y.*

For more information circle **208** on inquiry card.

Gas-filling Unit

New unit evacuates air from mechanical and electrical assemblies, back-fills with a partial pressure of an inert gas, and hermetically seals as-



semblies. In closing phases of exhaust cycle, oven may be filled with helium and a mass-spectrometer leak test made of air being evacuated from assemblies. Should a leak be indicated, each assembly can be probed individually; station isolated; and sound assemblies back-filled to any pressure desired and individually sealed off. Unit is available in several sizes.—*High Vacuum Equipment Corp., Hingham, Mass.*

For more information circle **209** on inquiry card.

Control Air Booster

New high-capacity air volume amplifier converts a loading pressure to a high-volume output pressure equal to loading pressure within 1 percent; is also available in ratio forms permitting each 1 psi. loading pressure to produce ½, ⅓, 2, or 3 psi. output pressures; is designed to speed up pneumatic control circuits,

air valve motors, and air cylinders. Less than 1 cu. in. of air is required from signal source to completely open booster's supply valve which will pass more than 35 cfm. free air with 90 psi. supply. Supply and relief seats are of equal size; same balanced design permits inner valve to float in air stream and contributes to performance: 50 psi. variation in upstream pressure results in less than 0.05 psi. change in downstream pressure on dead-end service.—*Kendall Controls Corp., 144 Moody St., Waltham 54, Mass.*

For more information circle **210** on inquiry card.

Sine-wave Generator for Pneumatic-control Tests

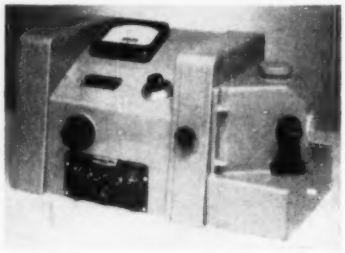
New Sine Wave Generator, for determining transfer functions of components of automatic control systems, is useful also in defining physical

properties of existing plants to which control systems are to be added. Data are acquired by frequency synthesis method in which sinoid is applied to system and measurements taken of amplitude and phase shift of output response. Instrument generates sinoidal air commands of adjustable frequency, amplitude and mean pressure; and provides auxiliary electrical signals for phase reference. Frequency is continuously adjustable in three overlapping ranges covering a spread of 72,000 to 1 (20 cps. down to 1 cph.)—*Librascope, Inc., 1607 Flower St., Glendale, Calif.*

For more information circle **211** on inquiry card

Color Comparator

New "Model C Color-Eye" retains proved features of earlier models (flicker photometry system, logarithmic ratio method of presentation, in-

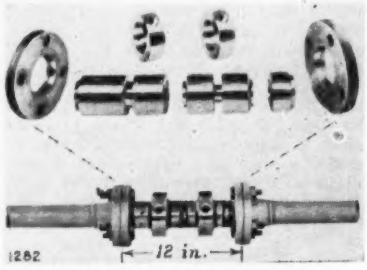


clusion or exclusion of gloss, stabilized source temperature, etc.). New features include: (1) filter turret for up to fifteen filters in one instrument with zero shift between filters reduced to 0.2 percent of measurement level; (2) integral forced cooling to eliminate effects of temperature rise at sample; (3) improved commutator: test life nearing 10,000 hours of continuous operation; (4) choice of diffuse (sphere) type illumination or 45 deg.-normal, two types interchangeable; (5) optional attachment to give automatic direct duodial reading in terms of x,y,z (daylight) in ICI terms within filter accuracies; (6) simpler access for routine maintenance.—*Instrument Development Laboratories Inc., 163 Highland Ave., Needham Hts. 94, Mass.*

For more information circle **212** on inquiry card.

Miniature Venturi Tube

New "Type TF Venturi," designed for measurement of gaseous or liquid fluids in quantities considered too small for normal-size Venturi or ori-



fice, may be furnished with inlet sizes of ½, ¾, 1, 1¼, 1½ and 2 inches; and four different ratios of throat-to-main in each size. Components are welded together to form a completely integrated assembly, each part having been machined to a tolerance of 0.0005 in. It is furnished with annular pressure-equalizing rings at point where main and throat taps are located and usually is equipped with flanged ends. (Screwed ends if specified.) Material: cast iron, stainless steel, or bronze, to suit fluid. Manometers, as well as inferential meters of indicating, recording and totalizing type, are available. —*Simplex Valve and Meter Co., 68th and Upland Sts., Philadelphia 42, Pa.*

For more information circle **213** on inquiry card.

Flow-rate Controller

New "Type SA" flow-rate regulator, for both clear liquids and liquids containing light solids—even hot tar solution and other similar materials—features a unique down-flow design which provides self-cleaning characteristics, prevents clogging and blocking by solids, and drains regulator with drainage of piping system. "Type SA" uses no air lines, pressure regulators, air filters, seal pots or other mechanisms; change in either inlet or back pressure results in an immediate correction of flow-rate. Capacities range from 2 to 10 gpm. for "Model 1-SA," to 100 to 550 gpm. for "Model 7-SA."—*W. A. Kates Co., 430 Waukegan Rd., Deerfield, Ill.*

For more information circle **214** on inquiry card.

Stainless-steel Trap

New float trap is made entirely out of stainless steel for draining corrosive liquids in chemical, food, drug, paper and other industries; is designed for 300-psi. pressure and maximum total temperature of 800 F.; is made in sizes ½-in. to 2-in.—*The V. D. Anderson Co., 1935 West 96th St., Cleveland 2, Ohio.*

For more information circle **215** on inquiry card.

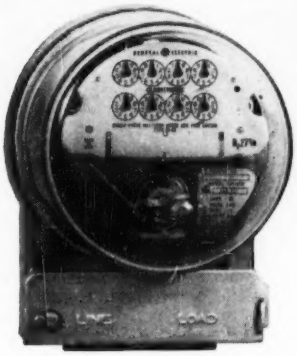
Two-hand Press Control

New "Micro Trip," two-hand clutch control for manually-operated power machines is said to increase production up to 25 percent; affords complete protection for operators and set-up men; is available as a package for installation on existing presses; prevents tying down or cheating because its two control switches must be pressed simultaneously to operate press.—*Micro Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.*

For more information circle **216** on inquiry card.

Combination Watthour Meter and Time Switch

New "Type IR 50" combination watthour meter and time switch, designed to control off-peak water-heater loads, has time switch a separate

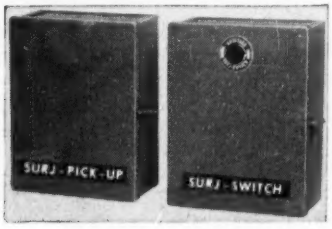


assembly from watthour register, greatly simplifying maintenance; is available with single-rate and double-rate registers.—*Meter and Instrument Dep't., General Electric Co., West Lynn 3, Mass.*

For more information circle **217** on inquiry card.

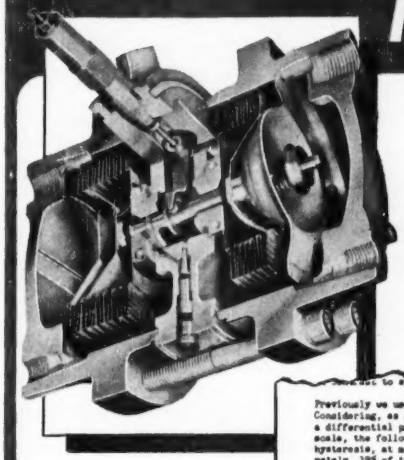
Current-surge Safeguard

New "Surj-Switch," a new type of electric control, operated by increased amplitude or surge of electric current when work is being done, is connected into one side or one phase of

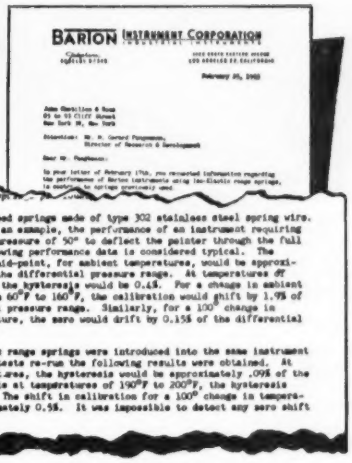


power circuit. Current surges produced by work operate a relay. When no work surge occurs, relay does not operate. Through use of built-in timers and/or auxiliary switches, interfering surges can be weeded out. Consequently, work-produced surge need not be the greatest in the work cycle to operate relay once for each work-producing operation. In timer-equipped models, both "Surj-Switch" and timer have relays; either or both relays may be used for control functions. A series of "Surj-Switches" and timer combinations provide flexibility to meet varied conditions and require-

HOW CHATILLON ISO-ELASTIC* SPRINGS IMPROVE BARTON INSTRUMENTS



*U.S.A. PAT. No. 2174171


BARTON INSTRUMENT CORPORATION

Previously we used springs made of type 302 stainless steel spring wire. Considering, as an example, the performance of an instrument requiring a differential pressure of 50" to deflect the pointer through the full scale, the following performance data is considered typical. The hysteresis, at mid-point, for ambient temperatures, would be approximately .196 of the differential pressure range. At temperatures of 190°F to 200°F, the hysteresis would be 0.45. For a change in ambient temperature from 60°F to 160°F, the calibration would shift by 1.9% of the differential pressure range. Similarly, for a 100° change in ambient temperature, the zero would drift by 0.15% of the differential pressure range.

When Iso-Elastic range springs were introduced into the same instrument and these same tests re-run the following results were obtained. At ambient temperatures, the hysteresis would be approximately .09% of the total range while at temperatures of 190°F to 200°F, the hysteresis would be 0.2%. The shift in calibration for a 100° change in temperature is approximately 0.5%. It was impossible to detect any zero shift whatsoever.

*Iso-Elastic is a temperature-compensated alloy produced solely by John Chatillon & Sons. Years ago this Company deemed it necessary to develop a material that would be unaffected by temperature changes, and at the same time have the best possible hysteresis and drift characteristics.

Chatillon realized the difficulty of such an assignment, and engaged the foremost consultants to assist with this development. Professor A. V. De Forest of the Massachusetts Institute of Technology, and Professor F. Sayre of Union College were retained as consultants for John Chatillon & Sons. After many years of intensive research, the now world-famous Chatillon *Iso-Elastic Alloy* was developed and patented. Soon thereafter, the Computing Scale Industry was first to realize the importance of *Iso-Elastic* for its precision spring requirements, for use in weighing scales. During recent years the importance of Chatillon *Iso-Elastic* has become very apparent to the aircraft, instrument, and electronic fields, since springs made from *Iso-Elastic* are virtually unaffected by temperature changes ranging from —50°F. to 150°F.

To improve the performance and accuracy of YOUR product contact our Spring Division. Engineering Bulletins on Chatillon *Iso-Elastic Alloy* and springs are available upon request.

JOHN CHATILLON & SONS
85 CLIFF STREET, NEW YORK, N. Y.
Manufacturer of Precision Springs and Measuring Apparatus Since 1835

For more information circle **39** on inquiry card.

NEW INSTRUMENTS

ments. A complete unit includes a "Surj-Pickup" and a "Surj-Switch." "Surj-Pickup" may be used with power circuit from 0 to 80 amps, any voltage, 50-60 cps. "Surj-Switch" can be furnished for either 115 or 230 v.ac. Both "Surj-Relay" and "Timer Relay" contacts are rated at 5 amps., 115 v.ac. non-inductive. Timers are adjustable from 1 to 15 seconds.—*The Autotron Company, Box 722-Q, Danville, Ill.*

For more information circle **218** on inquiry card.

Outdoor Lighting Controller

New photoelectric controller for sensitive control of series or multiple outdoor lighting circuits is built around a dip-soldered etched circuit,

simplifying maintenance. Built-in lightning protection is provided. Low-level illumination is offered with "Types P-1 and P-1A" for street lighting circuits; high-level illumination is handled with "Types P-2 and P-2A" for airport and sign lighting applications.—*General Electric Co., Schenectady 5, N. Y.*

For more information circle **219** on inquiry card.

Tape Recorder

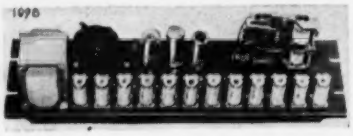
New "Telectrotape" is said to incorporate features found in recorders which heretofore sold for two and

three times its price: dual track recording; fast forward and rewind; tape speed 3¾ in. per second; high impedance input for microphone, radio, record player etc.; one hour of recording time from a 5-in. reel of tape; recording level indicator. Supplied complete with microphone, 5-in. reel of pre-recorded tape, extra reel and power cord.—*Telectrosonic Corp., 35-18 37th St., Long Island City, N. Y.*

For more information circle **220** on inquiry card.

Remote Selective Switching Unit

New "PCU-2 Pulse Counting Unit" is a remote-control terminal unit that responds to and channelizes telephone-dial-actuated pulses to perform selec-



tive switching operations. It is applicable to control and signaling operations by utilities, refineries, pipe lines, etc. Typical applications: selecting one of ten telemetering circuits when only one transmission circuit is available for sending metered information; controlling transmitters, receivers, lights, motors, pumps, valves, etc.—*Hammarlund Mfg. Co., 460 W. 34th St., New York 1, N. Y.*

For more information circle **221** on inquiry card.

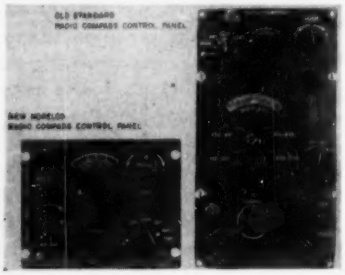
Ceramic Magnet

New "Indox" is a new type of magnet, composed of ceramic material lighter in weight than metal and requiring no critical ingredients. It is magnetized in the same manner as metals, but magnetizing force required is more than three times that necessary for Alnico (metallic permanent magnet in common use today). Announcement states that "it is virtually impossible to demagnetize the Indox material by any ordinary means." New magnet is best suited for uses in which application limits magnetic lengths and in which magnet may be subjected to high demagnetizing forces. "Indox" has a coercive force of approx. 1,600 oersteds and an intrinsic coercive force of approx. 4,000 oersteds. It can withstand demagnetizing fields above 2,000 oersteds without large loss of magnetic flux. It is characterized by short magnetic lengths, with an optimum working point of approx. 1,000 gauss at 800 oersteds.—*Indiana Steel Products Co., Valparaiso, Ind.*

For more information circle **222** on inquiry card.

Radio Compass Control

New "Models ED 100" (electric coupling) and "ED 200" (mechanical coupling) miniaturized control panel



units for AN/ARN-6 aircraft radio compass installations take half the panel space and have 3/4 the weight of previous designs.—*North American Philips Co., Inc., 750 South Fulton Ave., Mount Vernon, N. Y.*

For more information circle **223** on inquiry card.

Navigational Radar

New "Model 1500 Mariners' Pathfinder" radar retains all "big ship" type features and performance; is small enough for fishing vessels, tugs,

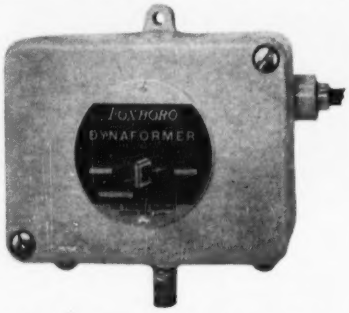
and similar small craft; is said to equal or exceed performance of other equipments on market costing twice as much. Among features: Parallel line cursor and bearing scale projected onto 'scope face where plot marks can be made with china-writing pencil; built-in tester gives instant check of system performance; 10-inch PPI with range scales of 1, 2, 4, 8, and 16 miles; system operates under temperature extremes from –20 F. to 140 F.; antenna operates normally at winds up to 75 knots.—*Raytheon Mfg. Co., Waltham 54, Mass.*

For more information circle **224** on inquiry card.

PRESSURE

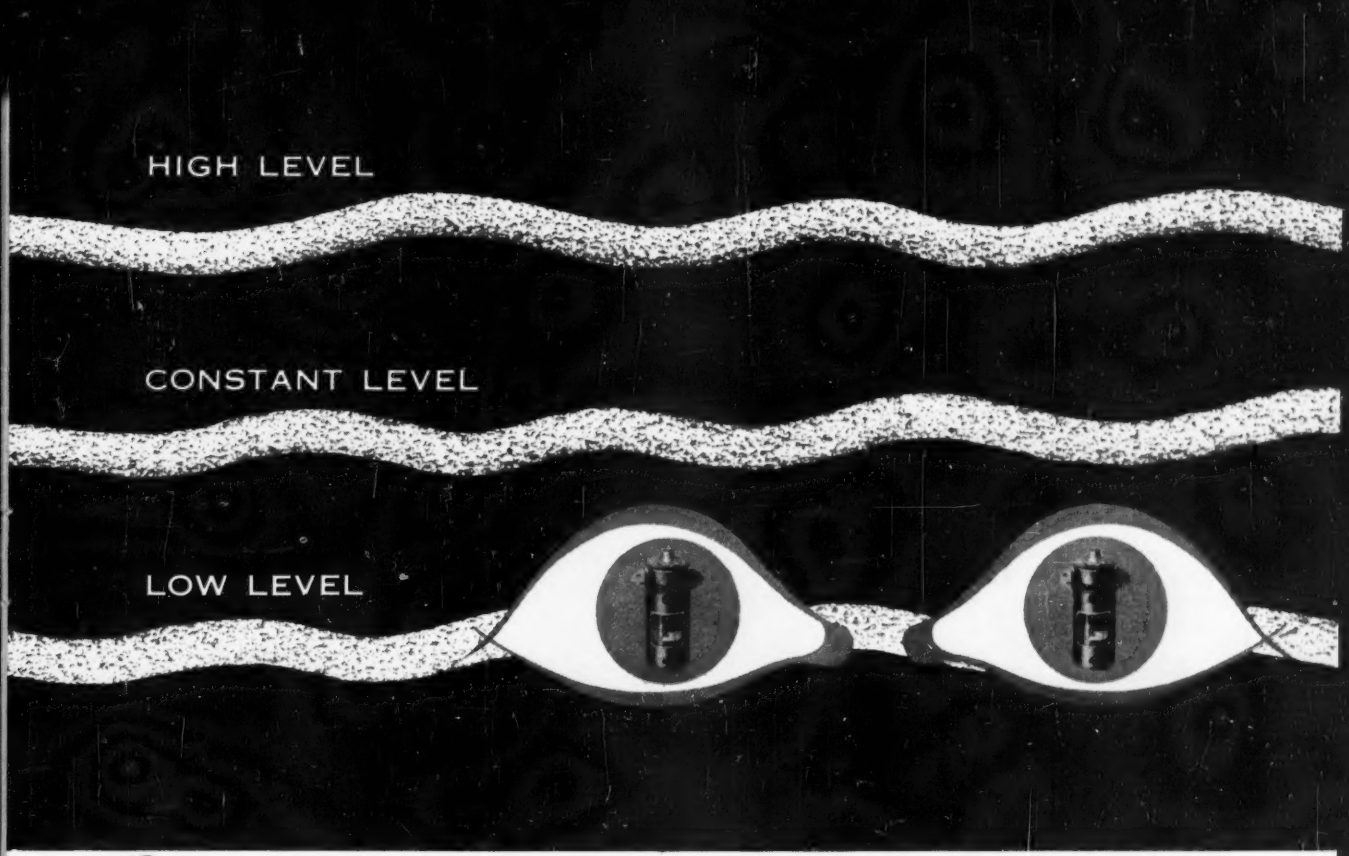
Pressure Transmitter

New "Dynaformer Pressure Cell" converts fluid pressure into a proportional alternating voltage which is measured in terms of pressure by



maker's "Electronic Resistance Dynalog Instrument." Unit consists of a Bourdon spring linked to a copper ring which surrounds iron core of a differential transformer. Responding to fluid pressure, spring displaces ring, inducing a differential voltage in output winding proportional to the fluid pressure. Accuracy is 0.25 percent "at any point." Unit is protected against overrange to 150 percent of its rating. A self-contained adjust-

Circle **40** on inquiry card. ⟶

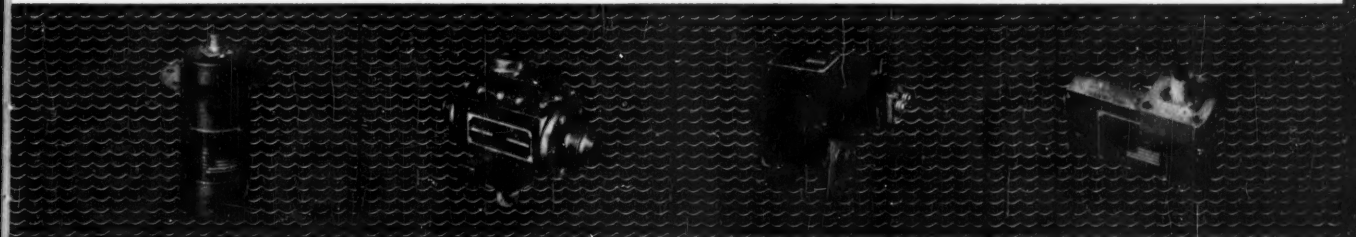


Revere INSTRUMENTS SEE WHERE YOU CAN'T

See *Revere* . . . if you need to know — **HOW MUCH LIQUID — HOW LITTLE — AT WHAT LEVEL.** *Revere's* precision made instruments are your unfailing eyes that see into sealed tanks, tubes or complex fuel lines. They can provide you with accurate measurement of liquid level regardless of pressure or temperature changes, vibration or rapid acceleration forces, AND they will automatically transmit a warning signal whenever liquid flow or level maintenance varies from a pre-determined value.

These hermetically sealed, magnetically actuated instruments employ balanced float assemblies to minimize false alarms. Compact and light, Revere instruments meet government specifications. They are available in many different configurations, some of which include relays to handle heavy electrical loads. Others are designed for complete submersion in fluids.

*Submit your control problem to our Field Engineering Department today. Revere will provide the instruments to tell you — **HOW MUCH — HOW LITTLE — AT WHAT LEVEL.** Shown below are some instruments that are the seeing-eyes of aircraft and industry.*

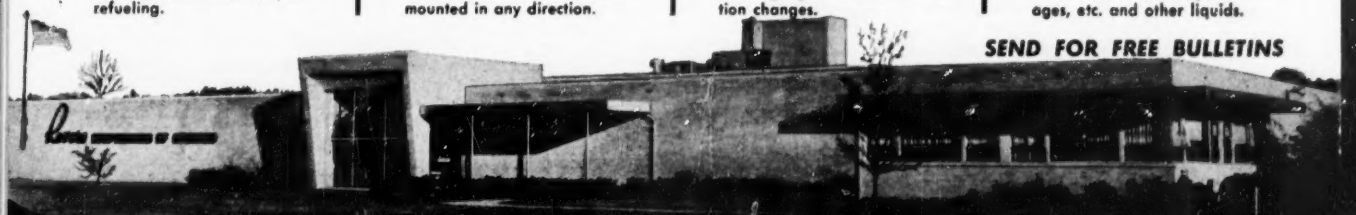


FLOAT SWITCH
Specially designed with single or dual float systems to provide automatic cut-off control for single point high pressure refueling.

FLOW SWITCH
Provides instantaneous warning signal whenever liquid flow falls below a pre-determined value. It can be mounted in any direction.

INDICATING SWITCH
Records the presence of fluid in a line whether stationary or flowing and transmits a warning signal if fluid condition changes.

FLUID LEVEL SWITCH
Used to maintain accurate high level, low level or constant level control of fuels, water-alcohol mixtures, beverages, etc. and other liquids.



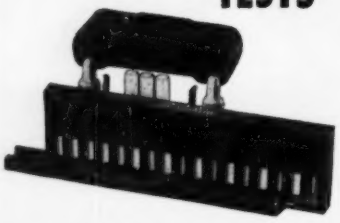
SEND FOR FREE BULLETINS

REVERE CORPORATION OF AMERICA
WALLINGFORD 2, CONNECTICUT, U. S. A.
precision instruments for aircraft and industry

"couldn't do without my

TAYLOR COMPARATOR

for pH, CHLORINE TESTS"



That's what chemists and engineers say in plants all over the country . . . because Taylor Comparators give you fast, easy determinations of pH, chlorine, phosphate, as well as complete water analysis. And you can make these determinations anywhere in the plant! No need to carry solution samples back to the lab since your Taylor set is lightweight, small, and no trouble at all to carry with you.

ACCURATE

There's no chance of mechanical inaccuracy because all Taylor Liquid Color Standards carry an unlimited guarantee against fading!

EASY TO USE

Taylor Comparators use the familiar colorimetric method of comparison, but without the need for fragile, single Nessler tubes. All color standards for a single determination are housed in a sturdy plastic slide. Many different slides may be used on the same base.

GET THE FULL STORY from your lab supply dealer or write for free book, "Modern pH and Chlorine Control". Gives theory and application of pH and Chlorine control, illustrates and describes full line of Taylor Comparators.

W. A. TAYLOR AND CO.
416 RODGERS FORGE RD. • BALTIMORE, MD.

For more information circle 41 on inquiry card.

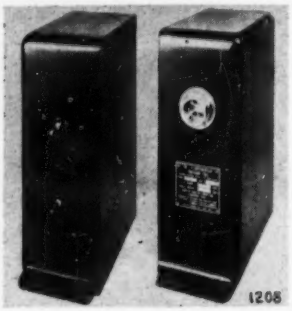
NEW INSTRUMENTS

ment enables user to match transmitter zero to that of instrument. Any pressure range between 0 to 30 in. Hg and 0 to 10,000 psi is available.—*The Foxboro Co., Foxboro, Mass.*

For more information circle **225** on inquiry card.

Differential or Absolute Pressure Transmitter

New "Type MMB" precision-grade differential pressure cell of bellows-pair type, based on SR-4 resistance

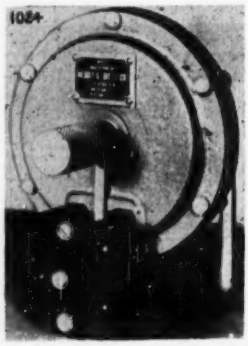


wire strain gage measurement, is made in two ranges: plus and minus 15 psi. and plus and minus 30 psi. Maximum base pressure 40 psi. Linearity is guaranteed within 0.1 percent of full scale over entire range of output. Hysteresis effect is less than 0.1 percent. Temperature compensation is commensurate with linearity. Pressure taps take small rubber tubing or may be provided with ¼-in. pipe thread.—*Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.*

For more information circle **226** on inquiry card.

Pressure Switches

New "Cat. 104 Sensitive Static Pressure Controls" are an improved version of "Cat. 104," with new and improved parts, such as molded screw



type terminals, etc.: better appearance, longer life, also possible to obtain units with silicone-impregnated glass-cloth diaphragms. New units are for application on low pressures where regulation is required in inches of water. Underwriters' Laboratories rated 10 amps. 125 v.ac. or 5 amps. 250 v.ac. Installation is simple: one hole to mount on a vertical wall or duct.—*The Henry G. Dietz Co.*, 12-16 *Astoria Blvd., Long Island City 2, N. Y.*

For more information circle **227** on inquiry card.

Test Pressure Booster

New "Hydraulic Pressure Booster" for intensifying pressure of city water supply can also be operated by air pressure; generates pressures up to

25,000 psi. for testing and calibrating. It consists of unit pistons which operate in unit cylinders. Pistons are packed with a low-friction non-leak sealing member whereby any predetermined pressure may be maintained indefinitely. Control is effected manually by needle valves. Three types: 5,000 and 10,000 psi. for operation on 150-psi. air or water, and 25,000 psi. for operation on 225-psi. plant or source pressure.—*Martin-Decker Corp., Long Beach, Calif.*

For more information circle **228** on inquiry card.

Gold Rupture Disks

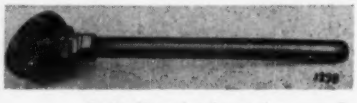
New low-pressure rupture disks made of gold are now commercially available for use in chemical and other industrial applications (outdoors, etc.). Tolerances can be held to 5 percent of specific bursting pressure for pressures above 50 psi. and to 2 psi. below 50 psi. These tolerances are said to be "closer than those offered by any other safety devices for the same operations." Disk performs same function as a safety valve; is not intended as a replacement but supplements it by offering double protection. Where simple precautions are taken, no metal is lost after a rupture; thus cost does not differ greatly from that of base-metal disks. Disks of precious metals other than gold, for pressures up to 10,000 psi., are available; composite disks of base metals faced with precious metals require additional manufacturing procedures.—*Baker & Co., 113 Astor St., Newark 5, N. J.*

For more information circle **229** on inquiry card.

TEMPERATURE

Metal-ceramic TC Tube

New "LT-1" thermocouple protection tube, combining thermal conductivity and shock resistance of metal with oxidation and deformation resistance of ceramics, has a wall thickness of ⅛ in. said to drastically reduce response lag. Material's thermal conductivity is about 29, which is about equal to that of cast iron and about 46 times that of borosilicate glass. Tubes are said to have strength at high temperature and to surpass most ceramics in resistance to thermal shock. They resist air oxidation, combustion gases, and attack by molten



Circle 42 on inquiry card. ⟶

PRECISION ENGINEERING
CUSTOM MANUFACTURING

THE TYPE 20

An Instantaneous Reading

BROAD-BAND SWR INDICATOR

The complete SWR Indicator System consists of two separate Scanning Oscillators covering the 400-900 Mc and 900-1350 Mc bands, a Reflectometer with a standard matched 50-ohm load, a Ratio Measuring Unit, interconnecting and power cables. The unknown load is connected to the Reflectometer, and the outputs of the Ratio Measuring Unit are connected to an oscilloscope (not supplied). Frequency is presented on the oscilloscope on the X axis, and SWR over the entire band is presented on the Y axis.

TYPE 20 SYSTEM:

AIL Type 21 Ratio Measuring Unit with self-contained power supply and overlay for 5 inch oscilloscope.

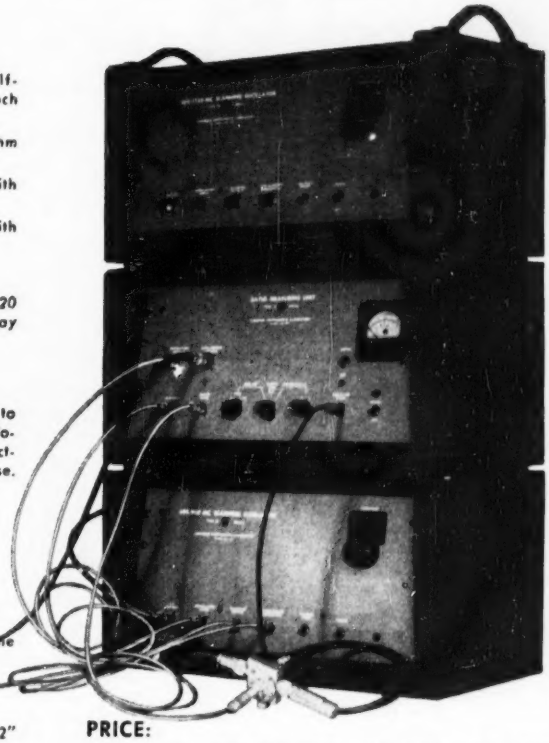
AIL Type 22 Reflectometer with precision 50-ohm reference load.

AIL Type 23 400-900 Mc Scanning Oscillator with self-contained power supply.

AIL Type 24 900-1350 Mc Scanning Oscillator with self-contained power supply.

Complete set of interconnecting cables.

(These units comprise the complete AIL Type 20 Broad-Band SWR Indicator System. Each unit may also be purchased individually as needed.)



SWR INDICATION:

Normal 1.0 to ∞ and, on expanded scale, 1.0 to 6.0. Automatically presented on calibrated oscilloscope scale at 56 presentations per minute. Direct-reading SWR meter for single-frequency manual use.

ACCURACY:

±10% of SWR indication

± 1% of Frequency indication

PRECISION REFERENCE LOAD:

50 ohms having maximum SWR of 1.05 over the two bands.

SIZE:

Each unit in carrying case is 11" high by 22" wide by 11½" deep. The height of the stacked system is 33" high with oscilloscope alongside.

Reflectometer size: 6" x 10" x 4"

All units are designed for rack mounting.

WEIGHT:

Low or high frequency system - 70 pounds.

Complete system - 100 pounds.

PRICE:

TYPE 20 SWR INDICATOR SYSTEM, COMPLETE WITH INTERCONNECTING CABLES less oscilloscope

Low Frequency System	$2,980
High Frequency System	$2,980
Complete High and Low Frequency Systems	$4,200

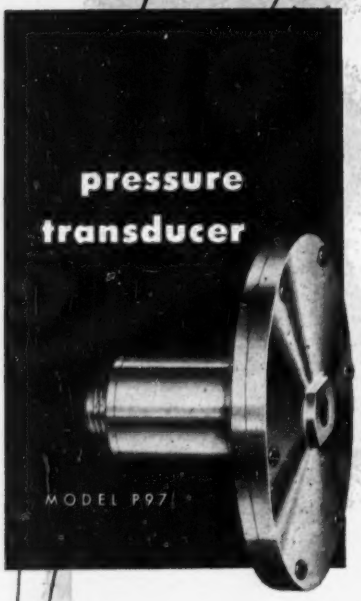
F.O.B. Mineola

Prices for individual units may be obtained upon request.

- Instantly measures standing-wave ratio over the 400-900 Mc and 900-1350 Mc bands.
- Eliminates tedious point-by-point data taking.
- Adjust antennas, transmission systems, filters, networks, receivers while under test.
- The Scanning Oscillators may be used separately as sources of r-f power, automatically scanned or manually adjusted to the desired frequency, giving 200-milliwatt minimum power output over the band into a 50-ohm resistive load.

Write for complete details

AIRBORNE INSTRUMENTS LABORATORY
INCORPORATED
160 OLD COUNTRY ROAD, MINEOLA, L. I., N. Y.



Differential or gage pressures in the range 0-0.05 psi are measured accurately and simply with the Model P97 pressure transducer.

The output of this instrument is 3.5 millivolts per volt full scale, permitting direct operation of a wide variety of commercially available recording, indicating, or controlling devices.

Pressure applied to the instrument is translated into an exact electrical equivalent by means of a full bridge transducer based on the unbonded strain wire principle.

Please request Bulletin No. 3.5.

Statham LABORATORIES
• Los Angeles 64, Calif.

For more information circle **43** on inquiry card.

NEW INSTRUMENTS

steel and slag. Available in lengths of 12, 18, and 24 in. New metal-ceramic well can also be supplied in a complete thermocouple assembly: straight type, connection-head extension type, and connection-head angle type.—*The Bristol Company, Waterbury* 20, *Conn.*

For more information circle **230** on inquiry card.

Multiconductor TC Cables

New multiconductor thermocouple cables, available in various sizes, are said to effect significant weight, space, and labor economies; ease of threading through conduit and possibility of using one common lead wire for many junctions. Cables are being made in all usual thermocouple metals with conductor sizes ranging down to No. 40. As many as 40 color coded wires may be included in one cable. Enamel, cotton, asbestos, glass, and vinyl are among insulating materials being used.—*Kinetic Engineering Co., M-217 Delaware Trust Bldg., Wilmington* 1, *Del.*

For more information circle **231** on inquiry card.

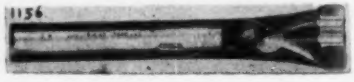
Dial Thermometer

New "Model 1850" straight form industrial dial thermometer has all external parts of stainless steel. Its stem and nut are joined into a single unit by a special stainless-steel welding process. Thus, all surfaces are smooth, corrosion-resistant, and non-contaminating: suitable for food, drug, chemical and other industries. Originally developed for processes involving radioactive materials, "Model 18-50" is in quantity production on "an economical cost basis." Its 6-in. dial chamber is hermetically sealed and each instrument undergoes a rigid submersion test. It is possible to reset pointer without breaking seal. Thermometer can be supplied with stem at any angle to dial face. Stem lengths 2½ in. to 48 in. All standard industrial temperature ranges, from −90 F. to 1000 F.—*Rochester Mfg. Co.*, 100 *Rockwood St., Rochester* 10, *N. Y.*

For more information circle **232** on inquiry card.

Plastic-enclosed Thermostat

New series of "Thermoswitch" thermostats, completely enclosed in a plastic sleeve, has been developed for severe humidity and corrosion service. Units can be used for temperature control or overheat detection for such applications as plating baths, pickling baths, humidity and corrosion testing chambers, etc. Unit can be set to operate at any temperature between 10 F. and 165 F.; can handle 10 amp. at 115 v. ac. or 5 amp. at 230 v.ac. Length, including plastic enclosure, varies between 5¼ and 7½ in.; diameter between ⅝ and 1⅛ in., depending on model.—*Fenwal Inc., Ashland, Mass.*



For more information circle **233** on inquiry card.

Manual-reset Thermostat

New "Uni-Therm" high-limit thermostat snaps off at a predetermined temperature; will not remake until user or serviceman pushes reset button. Its quick thermal response, obtained by metal-to-metal contact, makes it suitable for use on air-conditioners, room-heaters, or any appliance that calls for high-temperature protection. It can be obtained in a-c. or d-c. ratings in any calibration up to 550 F.—*Westinghouse Electric Corp., P. O. Box* 2099, *Pittsburgh* 30, *Pa.*

For more information circle **234** on inquiry card.

VIBRATION

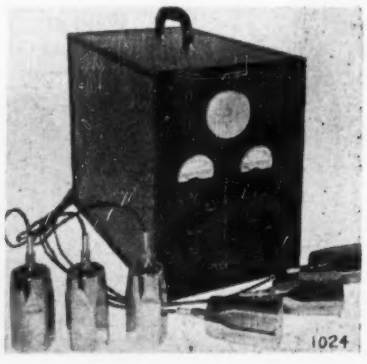
Hand Vibrograph

New "Askania Hand Vibrograph" weighs 3.75 lbs.; has amplitude range from 0.00001 in. to 0.375 in.; frequency range 0 to 250 cps. and acceleration to 50 G. It is driven by clockwork; its time markers are operated by a built-in 6-volt battery; it records by stylus on transparent waxed-paper tape.—*European Products Importing Co., Inc., 154 Nassau St., New York* 38, *N. Y.*

For more information circle **235** on inquiry card.

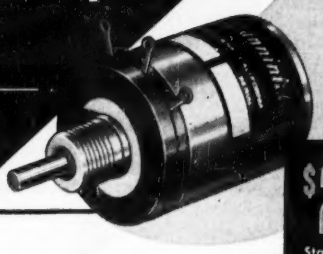
Vibration Analyzer

New "Model 553 Vibration Analyzer" permits selective readings of steady-state vibration phenomena from as many as six points on device or machine under test, while it is operating under any simulated circumstance of load or speed. Seismically-mounted inductive pickups are fastened at points of stress to be analyzed, connected through six-position-input selector switch. Peak-to-peak displacement is read directly in any of four ranges: 0.1, 0.01, 0.001 and 0.0001 in. full-scale; three fre-



advanced production techniques bring you...

advanced minitorque*

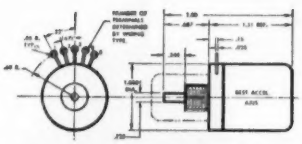


New design and advanced production techniques enable Giannini to bring you the advanced Minitorque* potentiometer at a NEW LOW PRICE. Here, from the leader in low torque potentiometer design and production, is a rugged, high accuracy unit, at half the price of comparable potentiometers.

The Minitorque* is a low torque Instrument Quality potentiometer 1" in diameter, with a stainless steel shaft and oilite sleeve bearing. Standard models with resolution from 0.06% to 0.19%, and linearities of ±0.5% are now *available for immediate delivery from stock.* The Minitorque* is especially adaptable to laboratory test equipment, computer systems, remote telemetering, and process control, where a dependable, lightweight potentiometer is required.

- Stainless Steel Shaft
- Dustproof Construction
- Positive Contact
- Low Torque Brush Design
- Moulded Plastic Body
- Platinum Alloy Wire

$20.00 Standard Model



STOCK MODEL SPECIFICATIONS**

LINEARITY: ±0.5% of total resistance, or better.

TORQUE: Starting: 0.025 oz. in.

SHAFT ROTATION: 360°.

WINDING ANGLE: 354° Minimum. (A minimum gap is provided so that brush will not short winding in region of 354° to 360°.)

TEMPERATURE COEFFICIENT: .00006 ohms/-ohm/°C max.

TEMPERATURE RATING: Operating range from −54° to +71°C.

ACCELERATION: Will function during acceleration of 50 G's applied along any axis.

VIBRATION: Will function during vibration of 0.060 in. total excursion, at frequencies varying from 10 to 55 cps applied along any axis.

VOLTAGE BREAKDOWN: Will withstand 500 v AC (rms) at 60 cps, between any terminal and shaft at sea level.

WEIGHT: 0.6 oz.

*Reg. U. S. Patent Office

These resistance values in stock for immediate shipment:

500 ohms	2K ohms	10K ohms	50K ohms
5K ohms	5K ohms	20K ohms	100K ohms

**There are twelve wiring types available, in addition to special modifications to customer's requirements.

Resistance (ohms ± 5%)	Maximum Current (ma at +25°C)	Average Total Turns
100	117	525
250	81	615
500	56	760
1,000	39	770
2,000	29	1,020
5,000	20	1,190
10,000	14	1,400
20,000	8.6	1,660
50,000	5.5	1,660
100,000	3.9	1,660

Giannini

For complete information, write for Minitorque Bulletin No. 111.*

G. M. GIANNINI & CO., INC. • PASADENA 15, CALIF. • EAST ORANGE, NEW JERSEY

OTHER GIANNINI POTENTIOMETERS

MODEL 85171A SPIRALPOT

Slide-wire; infinite resolution; low noise; linearity to ±0.01%. 1.812" dia. x 1.61". ¼" shaft. Resistances: 2 to 3750 ohms. 1 to 15 turns.

MODEL 85173A SPIRALPOT

Slide-wire; infinite resolution; low noise; linearity to ±0.025%. 3.312" dia. x 2.4". ¼" shaft. Resistances: 6 to 25,000 ohms. 1 to 40 turns.

MODEL 85111 MICROTORQUE

Extremely low torque (.003 oz.in.). Resolution to .06%; 1" dia. x 1.31"; shaft 0.031" dia.; 1.63 watts (average). Resistance: 250 to 25,000 ohms; 12 wiring types. Linearity: ±0.5% or ±0.25%.

MODEL 85193 MINIGANG

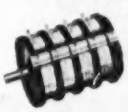
Rugged—small; resolution to .06%; 1.125" dia.; up to six sections; 2 watts per section. Resistances: 130 to 70,000 ohms. Linearities: ±0.5% or ±0.25%.

MODEL 8620 RECTIPOT

Linear motion; rigid metal case; 1" dia.; one or two elements; strokes from 0.2" to 6.0". Resistances: from 400 ohms/in. to 15,000 ohms/in.; taps available.

MODEL 85196 UNIVERSAL POTENTIOMETER

High accuracy; rugged. Resistances: 360 to 200,000 ohms. Linearities: ±0.3% to ±0.15%; 12 wiring types; sleeve or ball bearing models; 1.740" dia. x .81"; available with sine-cosine or logarithmic outputs.



MODEL 85197 UNIVERSAL GANGPOT

Up to 12 sections; 2" dia. Resistances: 360 to 200,000 ohms per section. Linearities: ±0.3% to ±0.15%; sleeve or ball bearings; sections phaseable 360°, solid shaft. Anodized aluminum case; log or sine-cosine outputs.

For more information circle 44 on inquiry card.

Atkomatic Solenoid Electric Valves are available in sizes from ¼ inch to 3 inches, and for pressures to 3,000 psi. Adjustable timing on the closing stroke is available on all valves up to pressures of 300 psi.

Designed with only three moving parts and no external linkage, wear and maintenance are greatly reduced. Availability for normally opened or normally closed operation makes it possible for the valve to fail safe in the event of power failure.

Atkomatic Solenoid Electric Valves are made with standard coils of paper insulation, vacuum impregnated and baked for resistance to moisture, or glass-insulated coils for higher temperatures.

Write for more complete information

For all your Solenoid Electric Valve Requirements, Look to . . .

Atkomatic

SOLENOID

ELECTRIC VALVES

ATKOMATIC VALVE COMPANY
525 Abbott Street, Indianapolis 25, Indiana

For more information circle **45** on inquiry card.

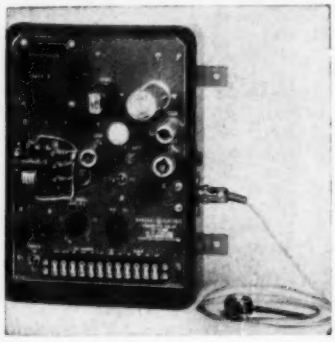
NEW INSTRUMENTS

quency ranges, 10,000, 20,000, and 40,000 cpm. full-scale; an oscilliscope permits visual observation and photographic recording of wave patterns. —*International Research and Development Corp.*, 168 *Hosack St., Columbus, Ohio.*

For more information circle **236** on inquiry card.

Vibration Monitor

New "Vibration Relay" initiates a signal when excessive vibration due to unbalance occurs in large rotating equipment; can be used at speeds



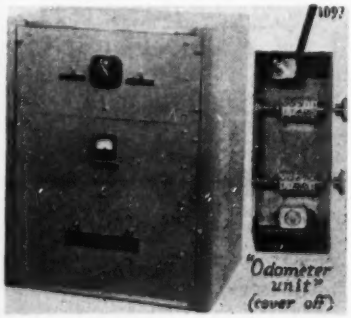
from 300 to 18,000 rpm. to energize warning-alarm, corrective, or shutdown devices at pre-set vibration acceleration values up to 20 *G*. A fail-safe feature gives warning when device itself fails because of electronic-component burn-out, etc. Acceleration-responsive element is a barium titanate crystal pickup whose output voltage is amplified then rectified to operate a s-p. d-t. relay. In order to calibrate and adjust instrument, a 1-volt rms. calibration signal is supplied by a bridge-type regulator whose output is controlled by a variable resistor calibrated "0" to "20."—*General Electric Co., Schenectady 5, N. Y.*

For more information circle **237** on inquiry card.

TIME, SPEED AND COUNTING

Electronic Timer

New "Model 1029A Hallikainen-Shell Development Electronic Timer" though designed for viscosimetry, finds applications where intervals from 0.1 sec. to 1000 sec. must be measured to 0.1-sec. accuracy. Tuning-fork-con-

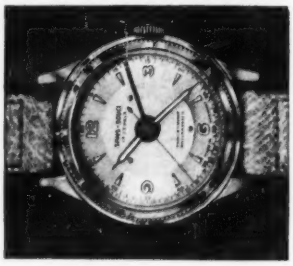


trolled amplifier provides a precise 115-volt 60-cps. supply with power output of 150 watts; can furnish power for as many as 36 cyclometer-type electric counters (or other units in plants where 60-cps. supply is not high-precision).—*Hallikainen Instruments*, 1341 *Seventh St., Berkeley, Calif.*

For more information circle **238** on inquiry card.

Alarm Wrist Watch

New "Edscorp" alarm wrist watch, imported from Germany, is a 17-jewel timepiece with luminous dial. Alarm is set by turning glass rim. Tone may



be adjusted to loud or soft by regulation of sound bridge. Watch runs 42 hours on one winding, is shock-proof, anti-magnetic.—*Edmund Scientific Corp.*, 174 *East Gloucester Pike, Barrington, N. J.*

For more information circle **239** on inquiry card.

Stroboscopic Frequency Standard and Indicator

New "Model 6T-4 Stroboconn" is a direct-reading stroboscope-disk-type frequency indicator and secondary frequency standard with temperature-in-

sensitive tuning-fork reference. A frequency signal presented to instrument (through any transducer supplying 1.5 millivolts) appears instantly and for duration of signal. Measurement or analysis of "drift" can be made at any instant. Range: 32.703 to 4,186 cps., can be extended indefinitely with suitable frequency-dividing equipment with no loss of 0.05-percent accuracy. —*C. G. Conn Ltd., Elkhart, Indiana*

For more information circle **240** on inquiry card.

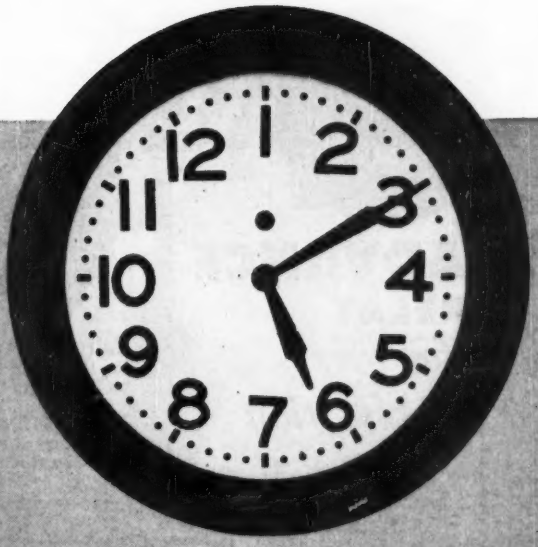
Digital Increment Indicator

New high-speed direct-reading counter indicates increments of measurement in radar navigation instruments. Double unit wheel has fifty

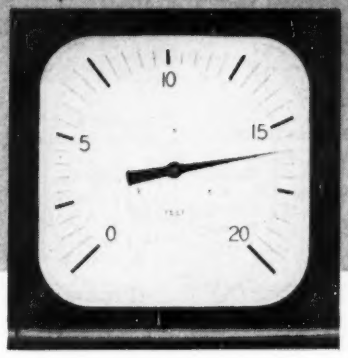
WHAT'S NEW AT BRISTOL . . .

HUMAN ENGINEERING

You wouldn't stand for a CLOCK like THIS



DOES IT SAY 16 OR 17?



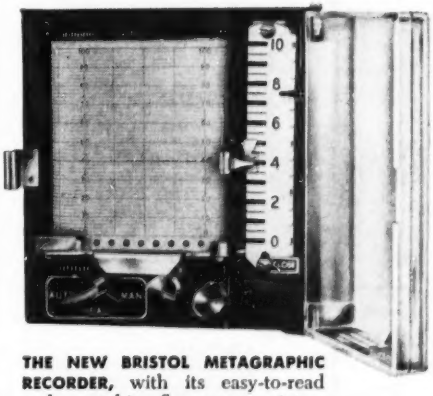
then why put up with an INSTRUMENT like THIS?

• Actually, there are thousands of instruments in use that are just as difficult to read as these. Take a look at the instrumentation in your own plant. Chances are you'll find plenty of examples of awkward scale division, unfamiliar zero positions, confusing graduations, not to mention shadows and reflections on scales.

Now Bristol instruments are "HUMAN-ENGINEERED"

Because measurement accuracy involves not only the accuracy of the instrument but the accuracy of the man reading the instrument, we have "human engineered" our charts and scales, making them easy to read, clearly visible at greater distances – so that instrument error becomes the limiting factor in the accuracy of the man-meter system.

Get the whole story of Bristol's human engineering – and how it can help you get accurate measurements, faster and easier. Write us. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.



THE NEW BRISTOL METAGRAPHIC RECORDER, with its easy-to-read scale, matching fluorescent pointers and shadow-proof door has earned a reputation as the "biggest little instrument in the business".

4.2

BRISTOL

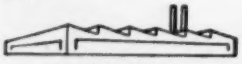
POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

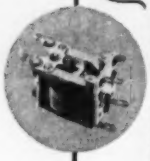
For more information circle **46** on inquiry card.

Functional Design

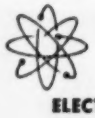
an **ADVANCE RELAY** *for every application*



INDUSTRIAL...
Unsurpassed relays for commercial and industrial applications. Advance can meet all requirements. They offer a complete line of rugged precision-built relays for your specific needs.



COMMUNICATIONS...
Designed for demands of minimum cost, compactness and dependability, Advance Communication Relays should be the number one choice for your valuable equipment. Each Advance Relay *must* and *does* meet the highest standards of precision and quality.



ELECTRONIC...
Engineered to meet the most exacting requirements of delicate electronic equipment, Advance provides a large selection of highly accurate relays—meeting demands of longevity, and critical environment.

AIRCRAFT...
Advance offers a complete line of AN approved, quality engineered relays for aircraft. They meet or surpass all Military and Civilian requirements. All are lightweight, compact and rugged. Some models available hermetically-sealed.

Write for catalog showing complete line and Advance engineering facilities.

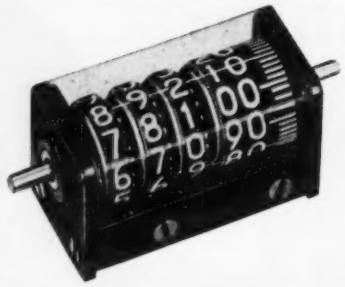
ADVANCE RELAYS

ADVANCE ELECTRIC & RELAY COMPANY

2435 NORTH NAOMI ST. • BURBANK, CALIFORNIA

For more information circle **47** on inquiry card.

NEW INSTRUMENTS



graduations which, combined with white indicator line etched on inside of lucite cover, makes for easy reading. Speeds up to 1800 rpm.: count reading of 90,000 increments per minute because of graduations on unit wheel.—*Durant Mfg. Co.*, 1941 *North Buffum St., Milwaukee* 1, *Wis.*

For more information circle **241** on inquiry card.

PHOTOGRAPHY, ETC.

Close-up Photography Device

New model of "Contameter" auxiliary close-up photography device is available for use on "Ikon Super Ikonta B and BX" cameras (12, 20, and 28-in. distances), and the "Ikon Contessa 35" camera (8, 12, and 20-in. distances).—*Carl Zeiss, Inc.*, 485 *Fifth Ave., New York* 17, *N. Y.*

For more information circle **242** on inquiry card.

Film Reader

New table model portable viewer with a 10.5x10-in. screen has interchangeable lenses, to provide magnifications of 7.5 to 14 (others on special order); film carriage located conveniently near table level to prevent operator fatigue; interchangeable 35-mm. and 16-mm. film carriages (special carriages for comparator work and other applications).—*D-H Instrument Co., P. O. Box* 205, *Station A, Palo Alto, Calif.*

For more information circle **243** on inquiry card.

X-ray Film

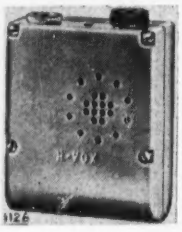
New "Type 510" ultra-fine-grain industrial x-ray film can be used at low voltages (10-20 peak kv.) to examine low-opacity materials such as aluminum, magnesium, corn, and wheat; with million-volt x-ray or betatron equipment, it may be used to examine steel up to 3 in. thick. New emulsion permits detection of tiny flaws: in spot-welding in aluminum sheeting, for detection of foreign contamination in grain prior to milling, etc. All standard sizes, packaged as "NIF" non-interleaved film which simplifies loading of holders for exposure.—*E. I. DuPont de Nemours & Co., Wilmington, Del.*

For more information circle **244** on inquiry card.

NUCLEONICS

Personal Radiation Alarm

New "R-Vox" sounds an audible alarm informing user when an overdose of radiation has been received; was developed by RCL in conjunction with Oak Ridge National Labs for use in labs where gamma radiation exists; weighs 9 oz.; may be belt-carried or may be used as an area monitor. Standard range is 100 milliroentgens. Exposure and/or instrument operation may be checked during use without loss of the accumulated dose. Penlight cell used for filament current may be readily replaced. Chambers up to 25 roentgens are available.—*Radiation Counter Labs., Inc., Skokie, Ill.*



For more information circle **245** on inquiry card.

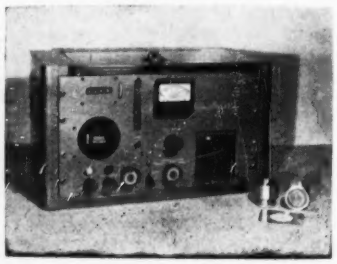
Radioactivity Absorbers

New "Model C-101" is a packaged set of radioactivity absorbers, consisting of 24 lead and aluminum disks mounted in uniform plastic rings. It is used with a Geiger tube mount and a scaler or count-rate meter to determine energies of photons and beta radiations, check isotope purity, identify radioactive species, study decay schemes, or to count a radioisotope in the presence of another.—*Nuclear Instrument and Chemical Corp.*, 229 *West Erie Street, Chicago* 10, *Ill.*

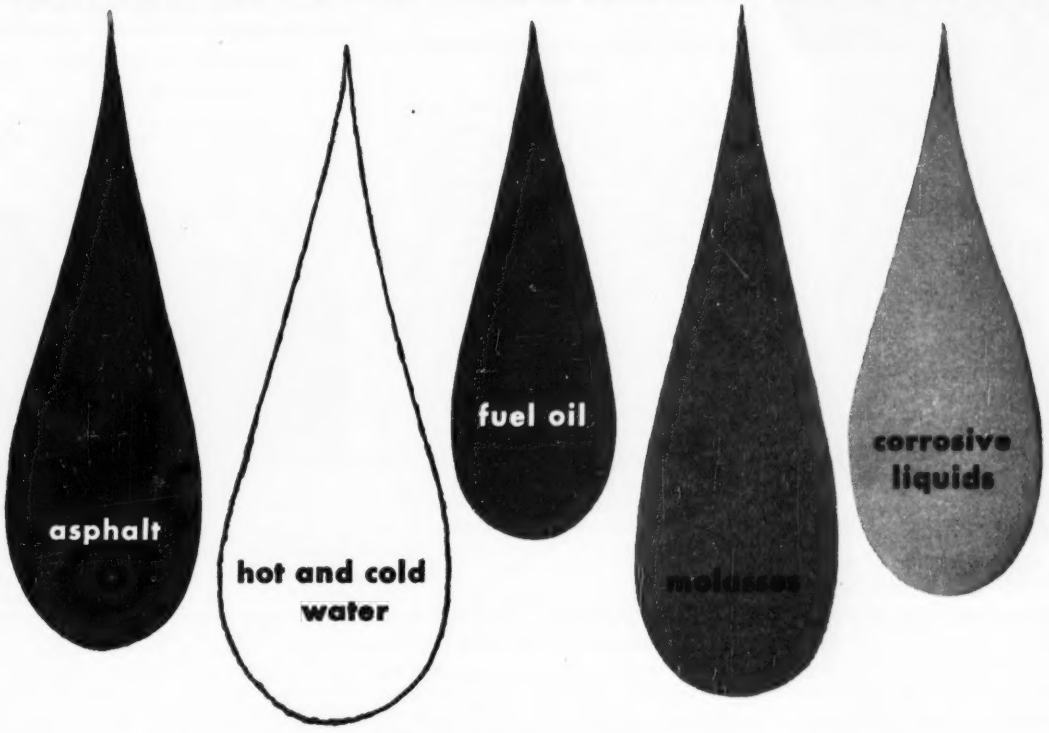
For more information circle **246** on inquiry card.

Alpha Scintillation Scaler

New "Model CX14" is an all-purpose scaler with built-in light-tight chamber for scintillation counting; incorporates an RCA 5819 photomultiplier tube: can be used for high efficiency alpha, beta and gamma scintillation counting through use of quick-change crystal phosphors; comes with external connectors for accessory Geiger tubes and scintillation counters; features binary type scales up to 256

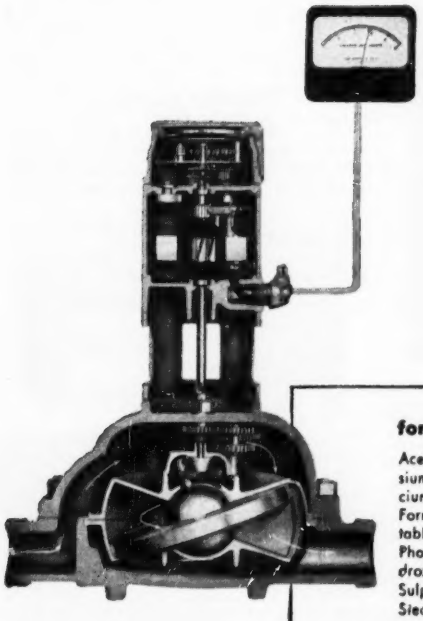


viscosities unlimited



HAYS VERIFLOW METER AND HAYS ELECTRONIC VERITROL

indicate and control liquid flow



Now virtually all fluids can be precisely measured and accurately controlled—*from a remote position.*

Hays VERIFLOW meter accurately measures, indicates, and totals the flow of corrosive and hard-to-meter liquids without using weigh tanks, orifice plates, or gage sticks.

With the Hays VERITROL you simply set a knob at the rate of flow desired . . . then, the VERITROL controls the flow of liquid at that set-rate.

Send for a complete description of Hays Veriflow Meter and Veritrol, Pub. No. 53-766-38.

for corrosive liquids

Acetic Acid, Aluminum Potassium Sulphate, Ammonia, Calcium Compounds, Carbolic Acid, Formaldehyde, Fruit and Vegetable Juices, Hydrogen Peroxide, Phosphoric Acid, Potassium Hydroxide, Sodium Compounds, Sulphuric Acid (concentrated), Stearic Acid, and many others.

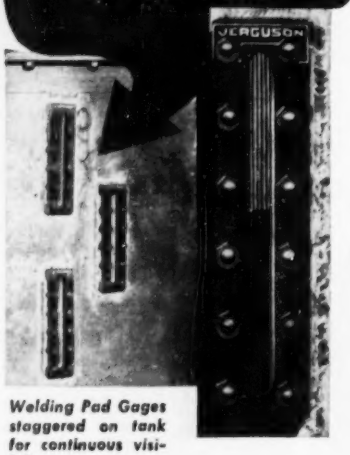
Automatic Combustion Control
Boiler Panels • Hays-Penn Flowmeters
Veriflow Meters and Veritrol
Gas Analyzers • Draft Gages
Combustion Test Sets • CO_2 Recorders
Electronic Oxygen Recorders
Electronic Flowmeters
Electronic Feed Water Controls
Miniature Remote Indicators

THE **hays** CORPORATION

Michigan City 8, Indiana

For more information circle **48** on inquiry card.

SPECIAL
JERGUSON
WELDING PAD GAGES
are integral part
of this tank



Welding Pad Gages staggered on tank for continuous visibility.

HERE is a special line of gages that weld right to the liquid containing structure, thus becoming an integral part of it. It solves problems where it is impractical for you to use a conventional type gage because of solids in suspension in a liquid, etc.

These Special Gages follow Jerguson Standard Gages in general design and materials, except for the method of attaching. The chamber of the gage consists of a bar steel pad which is welded to the vessel.

Welding Pad Gages are made in both Reflex and Transparent types . . . in all sizes of Jerguson Standard Gages. Pressure ratings are available to your specific requirements. Welding pad may be of any metal desired to withstand corrosive or other conditions.

Write for Data Unit on Welding Pad Gages for complete details. Whatever your gage problems, let Jerguson engineers assist you.

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY
100 Fellsway, Somerville 45, Mass.
Offices in Major Cities
Jerguson Tress Gage & Valve Co., Ltd., London, Eng.
Pétrole Service, Paris, France

For more information circle **49** on inquiry card.

NEW INSTRUMENTS

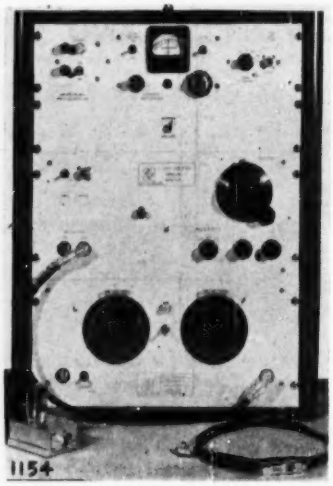
and uses a mechanical register in collecting to 10,000 (count presetable from 40 to 256,000).—*Reed-Curtis Scientific Instrument Co., Inc., 307 Culver Blvd., Playa del Rey, Calif.*
For more information circle **247** on inquiry card.

Coincidence-anticoincidence Analyzer

New "Model 412" coincidence-anticoincidence analyzer is said to be "unique in many ways." Fixed-resolution ranges are fixed for life of instrument, which will not go out of calibration when a tube is changed or repairs made. Output pulses are negative so that most types of commercial scalers may be used with instrument, which can be furnished with maker's "Model 14" multichannel scaler to form a complete self-contained unit. Among characteristics: input pulse negative 50 to positive 100 volts (or any combination of these); resolution ranges 0.25, 0.5, 1 and 2 usec.; channel output 25 volts negative; channel 1 may be used in anticoincidence with any other one or all of other three channels (switched on back of chassis to turn off channel 1); channel "deadtime" less than 10 usec.—*Radiation Instrument Development Labs., 2337 W. 67th St., Chicago 36, Ill.*
For more information circle **248** on inquiry card.

Multi-purpose Radiation Instrumentation

New grouping of instruments for laboratories working with radioisotopes is announced. (Top) "Model DZ16" precision voltage pulse gen-

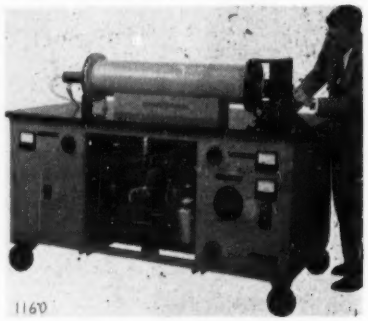


erator used to check performance of linear amplifiers and similar circuits, is similar to ORNL "Model Q-1066." (Center) "Model DZ15 Single Channel Analyzer" is a differential pulse height discriminator for obtaining amplitude spectrum. (Bottom) "Model DR8" linear amplifier for general laboratory work in conjunction with ionization chambers, proportional or scintillation counters, is identical in every respect with the famous "A1" circuit (ORNL "Q-541"). (Lower left corner) "Model DR10" preamplifier is used to match impedance of detector to input of "DR8 Linear Amplifier." It uses one 6AK5 tube, has a gain of approx. 1; is supplied complete with connecting cable.—*Detectolab, Inc., 6544 Sheridan Rd., Chicago 26, Ill.*
For more information circle **249** on inquiry card.

FOR THE LABORATORY

Vacuum Ultraviolet Spectrometer

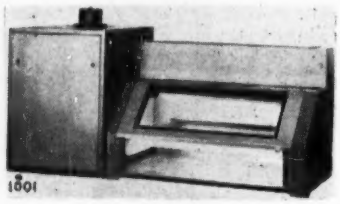
New vacuum ultraviolet spectrometer reproduces solar rays found only in outer atmosphere: at altitudes of 150 to 200 miles; is not intended as



a means of studying problems of space travel but as a means of basic research which may lead to such developments as improved phosphors, etc. Possible applications include optical absorption measurements on crystals, liquids and gases; photoconductivity measurements; determination of excitation spectra of phosphors; also studies with ordinary ultraviolet light. Source is a low-voltage high-current hydrogen discharge lamp (at left of cylindrical vacuum chamber). An aluminized grating (at right of cylinder) reflects u-v. rays upon crystals to be tested. Instrument operates on 115-v.a.c., has been designed for maximal flexibility of use. Delayed deliveries only.—*General Electric Co., Schenectady 5, N. Y.*
For more information circle **250** on inquiry card.

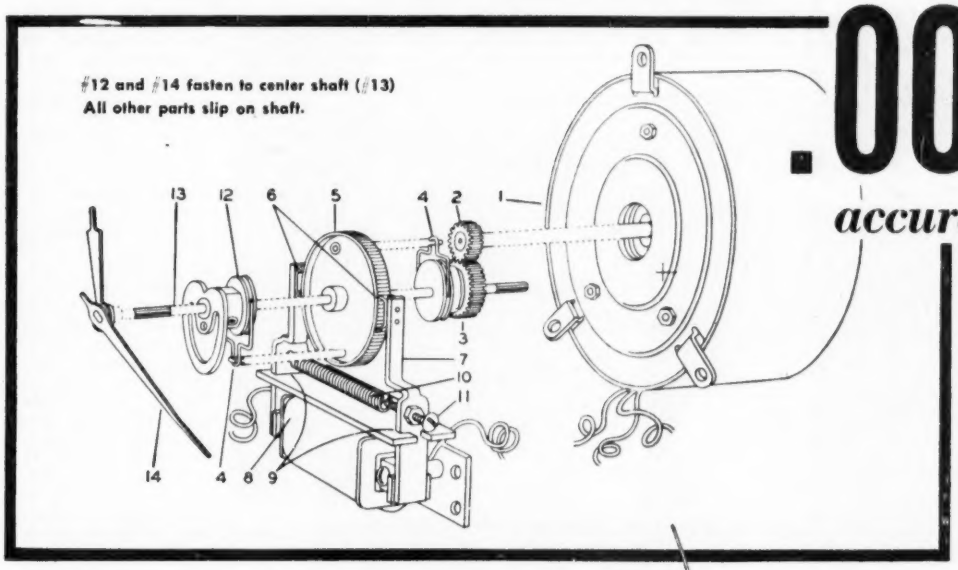
Sterile Cabinet

New "Model 12 Sterilshield" dust- and/or germ-proof cabinets is for instrument assembly, pharmaceutical, biological and other work where air-



borne particles are objectionable. Air is drawn through an electronic cleaner, removing particles of matter below 0.01 micron, then is forced into 40x24-in. workspace and maintains a pressure barrier around dust- and/or germ-proof area against outside contamination at 32x6-in. opening which permits freedom of movement of operator without restriction of arm holes, sleeves, or gloves. Two 30-watt fluorescent lamps illuminate work,

Facts behind the S-1 TIMER'S extraordinary



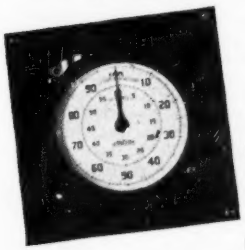
.005 SEC.
accuracy...

Formula S-1: **Expensive high torque, ball bearing motor, low inertia of moving parts, high proportion of precision and ground parts, no thrust bearings as found in ordinary clutches.**

- High torque (2 inch-ounce at 100 RPM) industrial grade motor (#1) with no internal gear train so small changes in load due to binds or hand acceleration cause no phase shift between rotor and rotating field . . . runs continuously to eliminate starting error.
- Precision cut gears (#2, #3). Any eccentricity or inaccuracies in gearing reflect directly in timer reading.
- Slip clutch composed of hardened steel spring (#4) riding a V-grooved graphited (for long wear) collet, applies .6 inch-ounces of torque to aluminum (for low inertia) control disc (#5) with over 314 tiny teeth in its periphery.
- To hold control disc (#5) at rest, 2 hardened steel brake shoes (#6), ground to square knife edges, grip periphery of control disc in 4 places . . . control disc position to under $1/2$ of a degree ($1/720$ second).
- Electro magnet (#8) pulls brake shoes away from control disc through armatures (#7). Air gaps kept to minimum for speed. Precision made fulcrums prevent stickiness or unequal movement of armatures.
- Adjusting screw (#11) adjusts tension of armature spring (#10) so that time between energizing magnet coil and starting of control disc is same as time between de-energizing magnet coil and stopping of control disc. This compensates for starting and stopping errors.
- Second friction clutch (#12) transfers control disc motion to center staff (#13); allows hands to be reset when control disc is held stationary.

"Gentlemen . . . Let me give you the formula for our astounding final accuracy of .005 sec. obtained with our D-C clutch S-1 Timer."

To Split the Split Second with ACCURACY, Take a Minute Now and Write Us for Engineering Data



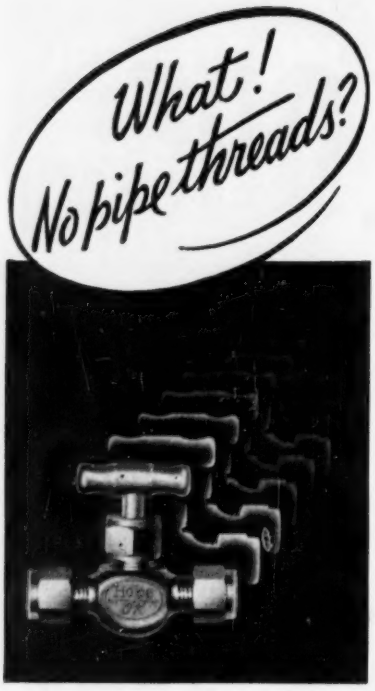
SINCE 1884 STANDARD

The STANDARD ELECTRIC TIME COMPANY

93 LOGAN STREET · SPRINGFIELD 2, MASSACHUSETTS

PRECISION TIMERS • CHRONO-TACHOMETERS • LABORATORY PANELS • PIPELINE NETWORK ANALYZERS

For more information circle **50** on inquiry card.



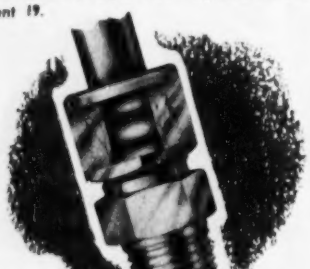
HOKE VALVES WITH

Swagelok®

ENDS

Now they are available from stock at Crawford Fitting Company and all Swagelok Distributors. These valves, manufactured by Hoke, Incorporated, Englewood, N. J., are equipped with Swagelok ends to provide leakproof and torque-free seals on every type of instrumentation installation. The arrow on the valve body shows direction of flow.

Hoke valves equipped with Swagelok ends are made in brass, aluminum, steel and stainless steel in sizes to meet your requirements. For further information and Swagelok catalog address Department 19.



Here's how the Swagelok fitting functions.

CRAWFORD FITTING CO.
884 East 140th Street Cleveland 10, Ohio
Teletype CV 785

For more information circle **81** on inquiry card.

which is viewed by operator through plate-glass window. Ultraviolet lamps available where exceptionally sterile conditions must be maintained.—*The Baker Co., Inc., Maplewood, Maine.*
For more information circle **251** on inquiry card.

Homogenizer

New 27,000-rpm. homogenizer for laboratory use is adaptable for both micro and macro work (volumes from 0.2 ml. to 50 ml.) and is said to offer "many exclusive features," among them: (1) universal heavy-duty motor linked with a built-in variable transformer; (2) fingertip speed control: (3) specially-designed fluted homogenizing flasks and razor-sharp 18-8 stainless steel cutting blades reduce homogenizing time to as little as 15 seconds; (4) wide volume range with three simple-to-attach flasks; (5) unique design of homogenizer permits changing flasks and blade assemblies in seconds; (6) both micro and macro blade assemblies available with specially-designed aerosol-free cap and washer which prevents escape of harmful aerosols into surrounding atmosphere.—*E. Machlett & Son, 220 East 23rd St., New York 10, N. Y.*

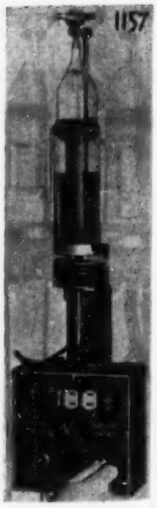
For more information circle **252** on inquiry card.

Automatic Toepler Pump

New "Urry Automatic Toepler Pump" is said to be superior to earlier Toepler Pumps in following respects: (1) more compact; (2) better support for the mercury with less danger of breakage; (3) larger piston volume in a reasonable size with shortest possible movement of mercury; (4) minimal movement of mercury allows high speeds: a pump with an 800-cc. piston volume and with a 35-sec. operating piston cycle can evacuate a 2-l. system to 0.15 percent of original gas in about 10 min.; (5) only a small amount of mercury in excess of working piston volume is required.—*Wakefield Industries, Inc., Skokie, Ill.*

For more information circle **253** on inquiry card.

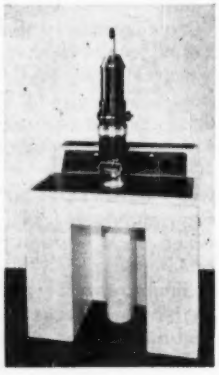
Automatic Absorption Apparatus



New "Fisher-Reeder Pipette" is a standardized unit for gas trains, which is claimed to double or even triple gas analyst's work output. It frees analyst from time-consuming selective absorption of various components of sample: A flick of a switch causes a solenoid-driven pump to inject four jets of absorbent chemical into automatic pipette's gas-filled chamber 24 times a minute (said to be the precise rate for optimum absorption). In addition, gas is agitated; mixing is thorough. After transfer, another flick of same switch causes still another component of sample to be absorbed in a second automatic pipette; then in a third, and so on.—*Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.*
For more information circle **254** on inquiry card.

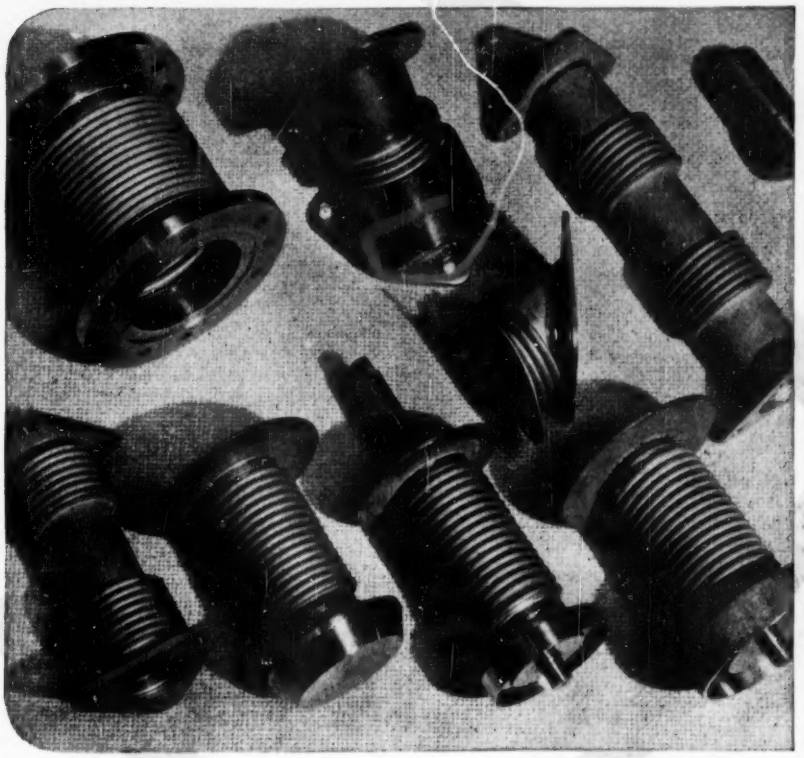
Electron Microscope

New "EM-75" electron microscope, at about half the cost and with about half the power of maker's "EM-100," utilizes an electron-optical system



that includes condenser, objective and projector lenses. Magnification is continuously adjustable between 1500 and 15,000. Resolving power is better than 100 Angstroms under average operating conditions. Electromagnetic deflection method is used for beam alignment and focussing is facilitated by a beam wobbler. Specimen airlock makes for quick working cycles. Stereoscopic exposures can be made without breaking vacuum. Camera using 35 mm. standard film permits making rapid sequential exposures without breaking vacuum, is controlled from outside of column; a special device prevents double exposures; an exposure register is built-in. All apertures accessible for cleaning without dismantling column; full safeguards of equipment against damage

STAINLESS STEEL BELLOWS ASSEMBLIES



...Designed for YOU to SAVE for you!

● Whatever your requirements for stainless steel bellows assemblies may be, you can be assured of getting *exactly* what you need from Fulton Sylphon or Bridgeport Thermostat.

We design and engineer assemblies to do specific jobs. For example—for use where there's a design problem involving control of temperature or pressure . . . opening and closing of valves, dampers, etc. . . . absorbing expansion . . . providing packless construction . . . for more uses throughout industry.

And add *these* advantages that help make savings for you: Half-a-century of experience in this specialized field . . . skilled personnel . . . complete production facilities . . . ability to produce in any volume. All combine to relieve you of production problems and worries, help save you time and money.

Consult us on your present bellows assemblies requirements—or on any project where an assembly must be designed for your specific needs. Stainless steel or other metals—wide size range. For information, write for idea-filled Catalog AE-1400.

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BRIDGEPORT 1, CONN.

For more information circle **52** on inquiry card.

Crucible Alnico Magnets help ruggedize Roller-Smith Instruments

13% smaller—same magnetic strength

When the Roller-Smith Corporation decided to ruggedize their electrical instruments to meet Military Specifications, they discovered that they needed a smaller permanent magnet—one that would do the same job as the old one they were using.

They called on Crucible's technical service for assistance. In short order, Roller-Smith's objective was attained. For through improved design, and better quality control in production, Crucible developed an alnico magnet that was 13.5% smaller and lighter than the previous one . . . but with the same magnetic strength.

The Roller-Smith story is typical of the many cases solved with Crucible Alnico Magnets, because Crucible magnets have the highest gap flux per unit of weight of any on the market. Crucible has been the leading producer of Alnico Permanent Magnets since the industry started. When you have a magnet problem, call on Crucible.

CRUCIBLE first name in special purpose steels

54 *years of* Fine *steelmaking*

PERMANENT ALNICO MAGNETS

CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

STAINLESS • REX HIGH SPEED • TOOL • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS

For more information circle **54** on inquiry card.

through breakdown or faulty manipulation; high tension cannot be switched on when equipment is not in proper working condition; operator fully protected against x-radiation under all circumstances.—*Research & Control Instruments Div., North American Philips Co., Mount Vernon, N. Y.*

For more information circle **255** on inquiry card.

Optical Bench

New type of optical bench has a unique lens-centering device said to be rapid in use; lens-holding capacity of 3 in.; removable collimator with a 3.25-in. diam. 46-in. F.L. objective, and reticle slide. Nodal slide is controlled in all motions from panel under microscope. There is micrometer motion of all slides. Scale divisions read to 0.001 in.—*L. C. Eichner Instruments, 19 Sebago Street, Clifton, N. J.*

For more information circle **256** on inquiry card.

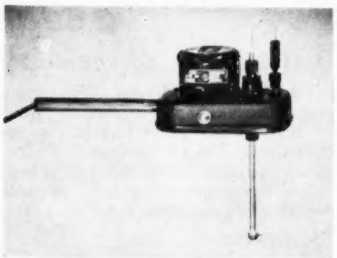
Freeze-drying Units

Two new freeze-drying units (one all-glass and one stainless steel) are designed to process small to medium quantities of bacteria, plasma, serums, etc. Both being completely self contained, they obviate need for conventional dry-ice chamber. Stainless steel unit, with cooling chamber of 2.8 liters, holds enough dry ice and solvent for unattended overnight operation; can be autoclaved after use with infectious materials; incorporates 14 taps, two for vacuum pump and gage and 12 for drying flasks. All-glass unit has three drying ports around its lower periphery and one port for either drying or for a drip trap at base.—*E. Machlett & Son, 220 E. 23rd St., New York 10, N. Y.*

For more information circle **257** on inquiry card.

Synchronous Rotator

New synchronous rotator, for use in amperometric titrations with rotating metallic micro electrodes, requiring constant speed of rotation, has a hol-

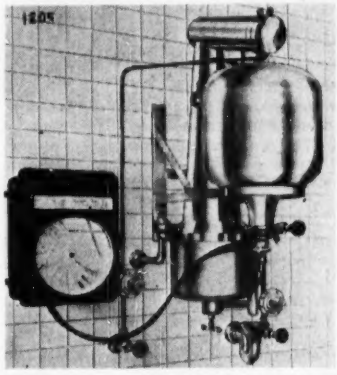


low-shaft chuck (to hold electrode securely in line with axis of rotation) and a constant-speed drive, assembled with a terminal connecting post and line switch. Drive is by a heavy-duty capacitor type synchronous motor which, when connected to 60-cps. line, drives chuck at a constant speed of 600 rpm., found to provide the most reproducible results in amperometric titrations.—*E. H. Sargent & Co., 4647 W. Foster Ave., Chicago 30, Ill.*

For more information circle **258** on inquiry card.

Water Still

New "Precision Type" steam heated water still provides for automatic removal of released gases from condenser. A continuous check on purity

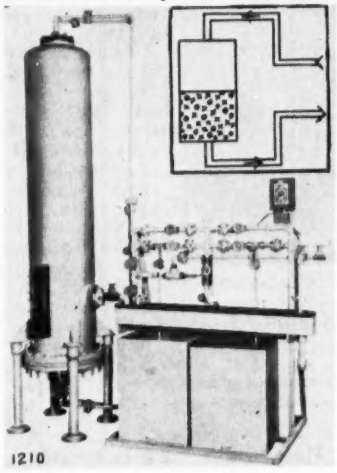


of distillate is visualized by automatic recording conductivity meter. Vapor tower has 30-in. rise between water level in evaporating pan and condenser. Still is designed for preparation, at rate of 10 gph., of high-purity pyrogen-free distilled water.—*American Sterilizer Co., Erie, Pa.*

For more information circle **259** on inquiry card.

Water Demineralizers

New "Mixed Bed Water Demineralizers," said to feature latest engineering developments in ion-exchange process of water purification, include



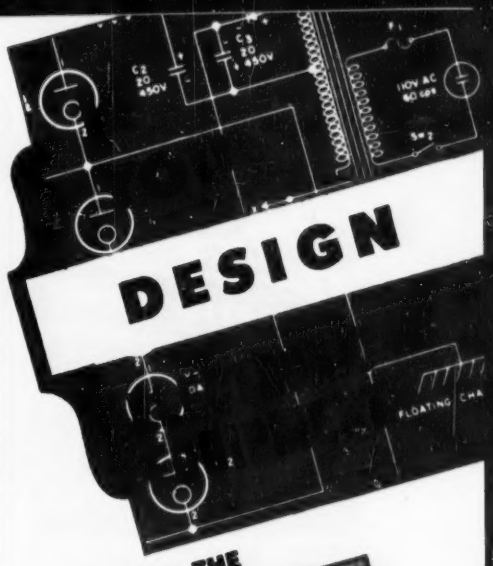
an improved system for regeneration of purifying resins after they have become exhausted. Capacities run from 50 to 2,500 gph. of mineral-free water. Effluent water electrical resistivity, often up to 20,000,000 ohms per c.c., is said to be "invariably higher than can be obtained with other types of demineralizers."—*Barnstead Still & Sterilizer Co., 244 Lanesville Terrace, Forest Hills, Boston 31, Mass.*

For more information circle **260** on inquiry card.

Electrophoresis Unit

New paper electrophoresis unit is for separation, identification and quantitative determination in such complex systems as mixtures of amino acids, lipids, steroids, carbohydrates

For more information circle **53** on inquiry card. →



YOU NEED THE SIE MODEL R-1 AC - DC VOLTMETER

The SIE R-1 Voltmeter is the only instrument of its kind especially designed as a precise laboratory meter for measuring AC and DC voltages from .0001 to 1,000 volts. It incorporates a stable direct-coupled oscilloscope pre-amplifier, a wide-range ohmmeter, a standard cell for calibrating and the SIE "Distended DC Scales" for measuring small changes in large voltages with an accuracy of .01 percent. In circuit analysis, design and development, this voltmeter replaces instruments whose total cost is many times as much. Covering the frequency range from DC to 100 kc, it finds application in audio, ultrasonics, geophysics, servo-mechanisms, computers, vibration analysis and general instrumentation. Price f.o.b. Houston: Complete with line cord, test leads and instruction manual . . . $620.00. Specify bench or rack-mounted model.

Write today for descriptive literature.

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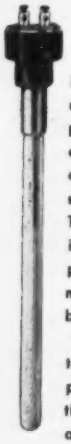
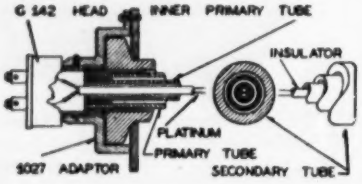


A background of many years of experience and "know-how" go into the production of Gordon Platinum, Platinum-Rhodium Thermocouples. From this experience has evolved the Gordon policy which calls for the utmost in quality and service, the utmost in value to clients. That is why Gordon platinum wire is carefully checked for thermocouple accuracy against a master thermocouple... calibrated and certified by the National Bureau of Standards.

The porcelain insulation and protecting tubes which go into a complete thermocouple assembly are of the finest quality obtainable. They are the best known means of preventing contamination of the elements which result in false e.m.f. values. Also, the Gordon G-142 head which goes



into a complete thermocouple assembly is light in weight and permits easy replacement of new elements into a protecting tube assembly.

The Gordon Policy—highest quality and standards of material — plus Gordon craftsmanship at the lowest possible price.

Write now for full information and price list.

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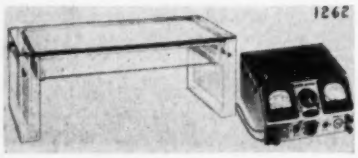
For more information circle **55** on inquiry card.

NEW INSTRUMENTS



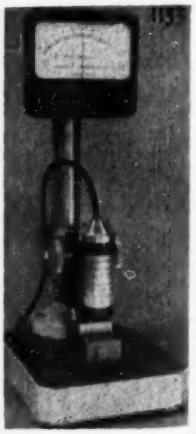
and proteins. Up to ten analyses can be made simultaneously. Buffer cells and tray for supporting filter paper are made of clear plastic. Different length trays can be used depending on length of paper necessary for analysis. One stainless steel and one carbon rod are used as electrodes in buffer cells.—*Microchemical Specialties Co., 1834 University Ave., Berkeley 3, Calif.*

For more information circle **261** on inquiry card.

FOR INSTRUMENT SHOP

Microinch Comparator

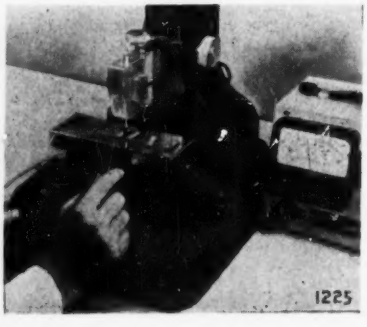
New "Model FN-1 A Super Comparator" is applicable to dimension checking, making comparison checks to accuracy of one microinch. There is no physical contact between comparator and metallic part being measured: no marring of finest mirror finish on softest metal. Establishment of the "go" and "no go" limits on indicator makes possible a complete check of dimensions in one plane in one operation. All reference surfaces are ground and finished to gage-block accuracy. Comparator may be used also as a displacement gage in check of radial runout, expansion and contraction, etc.—*Rutishauser Corp., 490 S. Fair Oaks Ave., Pasadena 1, Calif.*



For more information circle **262** on inquiry card.

Microinch Comparator

New "Half-Millionths Micro-Ac Electronic Microcomparator" provides dimensional gaging in increments of half-millionths of an inch. It comprises (1) an induction-type gage head with frictionless movement, adjustably mounted on a rigid stand; (2) a drift-free industrial-type amplifier; (3) an indicator with two continuous linear scales which read 0.5 microinch and 1 microinch per division, either side of center zero; respective measurement ranges being 10 and 20 microinches. (Other ranges and sensitivities can be provided for the less-sensitive scale.) Scales can be used interchangeably, selected by a knob; both give same reading for any measurement within their range. Repeat readings within one-quarter microinch are said to be consistently obtained. Instrument can be used in any room where temperature is fairly constant, and where there are no drafts or hot spots.—*Cleveland Instrument Co., 735 Carnegie Ave., Cleveland 15, Ohio.*



For more information circle **263** on inquiry card.

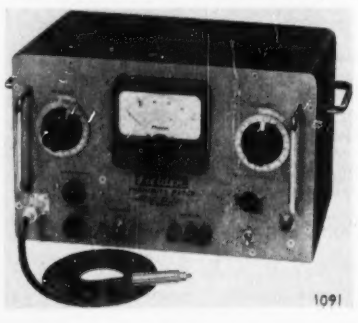
Mechanical Comparator

New "Sigma Vertical Mechanical Comparator" (made by Sigma Instrument Co., Letchworth, England) is suitable for use at production line, in tool-room, or in inspection department. Eight models available, with magnifications of 500, 1000, 1500, and 3000; and capacities of 6 in. and 12 in. No slackness or backlash in mechanism. Vertical adjustments provided for head and table; final setting on scale. Uniform measuring pressure on measuring spindle makes accurate readings possible over entire scale range (ranges from 0.012 in. to 0.002 in.). Scale is 6 in. long. Adjustable limit indicators can be locked in position. Throat depth on all models, 3¼ in. Anvil table is reversible. Immediate delivery from New York stock.—*Cosa Corp., 405 Lexington Ave., New York 17, N. Y.*

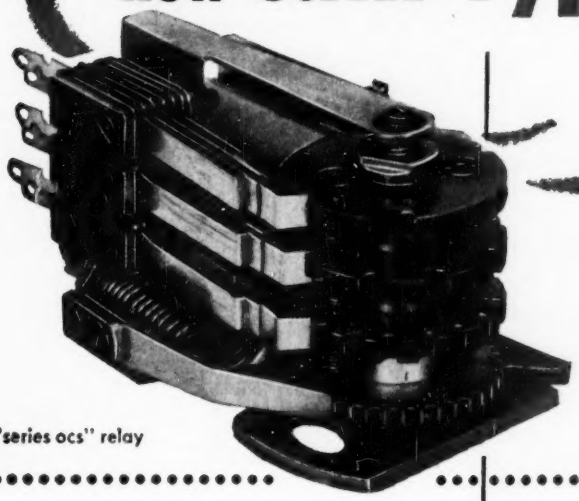
For more information circle **264** on inquiry card.

Capacitance Micrometer

New "Proximity Meter Capacitance Gauge" compares, measures, or monitors dimensions and distortions impossible to obtain by mechanical means; operates on changes in capacitance of specimen under test; is sensitive to 0.05 uuf. Among uses: (1) to



new cam-type relay



"series ocs" relay

"series ocs" combines relay and stepping switch functions

"OCS" RELAY SPECIFICATIONS

cams—Each revolution is divided into 36 steps—any combination of "operated" or "unoperated" intervals can be provided.

contact arrangement—Maximum of 6 contact springs for each of the 3 cams.

spring contacts—Twin contacts. Will make and break load of 150 watts (maximum 3 amps.). "Heavy-duty" single contacts can be provided for higher current.

speed of operation—Self-interrupted, 65 steps per second; impulse-controlled, 30 steps per second.

voltages—Nominal dc voltages: 6, 12, 24, 48 and 110. A rectifier can be furnished for 115 volt, ac, 60 cycles.

vibration—Withstands up to 10.5 G.

shock and acceleration—Up to 25 G.

ambient temperatures— −55°C. to +75°C.

weight—14-20 oz.

size—3 1/4" x 2-7/16" x 1-25/32".

. . . PROGRAMMING IS CUSTOM-DESIGNED

Here's a shock-resistant relay which can be used for cam-switching . . . for alternate on-off operations . . . or as a "stepper". *You* specify the programming when you order Automatic Electric's "OCS" Relay—select a contact sequence to fit *your* applications. This compact unit simplifies engineering—cuts space, weight, maintenance costs.

cam-switching — You can replace whole banks of relays and combinations of relays and stepping switches with this versatile unit. Dependability of the stepping mechanism is proved by performance records exceeding 250,000,000 high-speed operations! That's really performance!

alternate on-off operations — You can specify this rugged new relay as a replacement for the delicate latch-in type relay. "OCS" will give you excellent service under extreme conditions of shock, vibration, and temperature variation.

stepping operations — Stepping is high-speed, accurate and dependable. Can be driven self-interruptedly to produce a time cycle or for "homing".

Complete data on Automatic Electric's new "OCS" Relay can extend the scope of your planning. Write today to: Automatic Electric Sales Corporation, 1033 West Van Buren Street, Chicago 7, Illinois. In Canada: Automatic Electric Sales (Canada) Ltd., Toronto. *Offices in principal cities.*

RELAYS SWITCHES

PRODUCTS OF THE INDUSTRIAL DEPARTMENT OF

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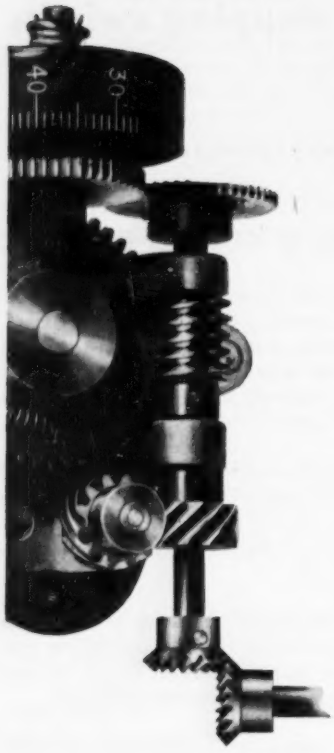
QUAKER CITY GEAR . .

producing gears of every description for the Electronic Industry . . . including ground thread worms and spiral bevel gears



We Invite Your Inquiry

For more information circle **57** on inquiry card.

NEW INSTRUMENTS

measure concentricity of shafts, rotors, etc.; (2) as a micrometer without any physical contact with the specimen; (3) as a dielectric comparator to determine composition or quality of conducting or non-conducting materials, whether solid, liquid or gas; (4) to measure thickness of paint or insulating materials bonded to metal surfaces; (5) miscellaneous—as a strain gage, autoweigher, surface gage, dynamic or static torque meter, etc.—*Fielden Instrument Div., Robertshaw-Fulton Controls Co.*, 2920 *North 4th St., Philadelphia, Pa.*

For more information circle **265** on inquiry card.

Classification Tray

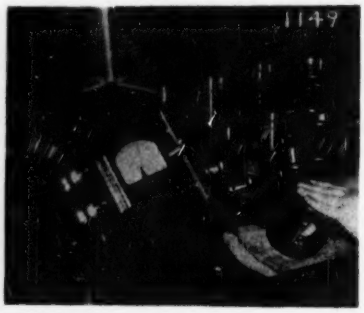
New gage accessory helps segregate ball bearings into any one of ten dimensional classifications after gaging. Illustration shows a ten-place

classification tray being used with maker's "Visual Gage." Operator takes reading and moves tray until proper size compartment is under ejection chute. No special skills are required to rapidly classify ball sizes in increments of ten microinches.—*The Sheffield Corp., Dayton* 1, *Ohio.*

For more information circle **266** on inquiry card.

Surface-roughness Measuring Instrument

New "Surfindicator," for measuring surface roughness, has a measuring range extending from 1 to 1000 microinches average deviation from mean surface. Feature is a variable-cutoff switch that permits separating "waviness" from roughness by filtering out wavelengths exceeding 0.003, 0.010, or 0.030 inch. Operating principle: as diamond-tip stylus moves horizontally across surface, microscopic vertical motions are transformed by a movable-plate vacuum tube into electrical signals which are

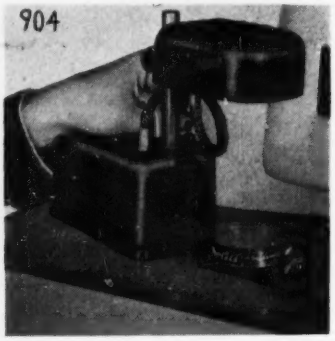


amplified and indicated as surface roughness in microinches. Operator need only select proper roughness and cutoff scales, guide pickup over work, and read indicator. Instrument comes with "Precision Reference Specimens" for calibration, which comply with ASA Standard B 46.2 and with SAE requirements.—*Brush Electronics Co.*, 3405 *Perkins Ave., Cleveland* 14, *Ohio.*

For more information circle **267** on inquiry card.

Monochromatic Light-source

New "Utility Monolight" is a 2-in. helium monochromatic light generator for inspection of flatness, finish and size with optical flats. Base is 7 in.

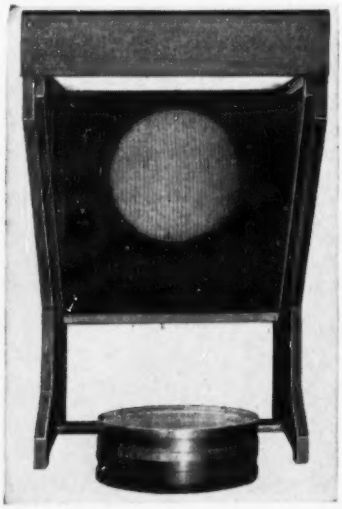


long x 3½ in. wide. Small size permits use at production machines and production inspection stations, or by roving inspectors. In use directly on work surface of a machine tool or on a surface plate, head is rotated to rear and work is placed under head, which may also be removed from instrument and held by hand.—*The DoALL Company, Des Plaines, Illinois.*

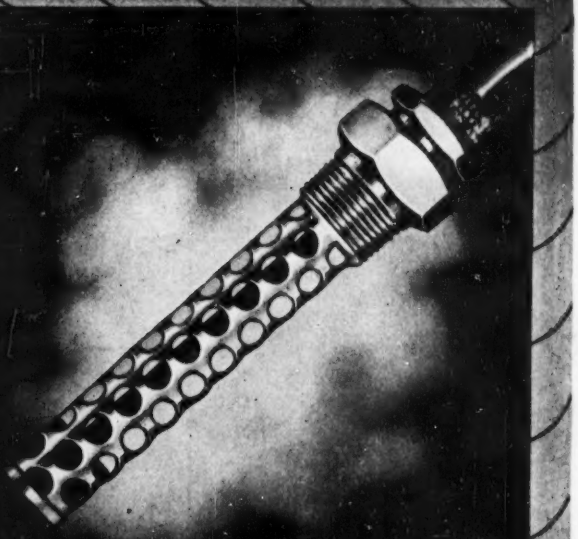
For more information circle **268** on inquiry card.

Monochromatic Light-source

New "Model 700-L" large-field monochromatic lamp, for use in laboratory or shop, where absolute interpretations of interference fringes are required, is of bench type cabinet construction featuring "straight-line" viewing of fringes (line of vision perpendicular to surfaces being inspected). This is said to eliminate common errors resulting from inspection of



Amazingly simple way to MEASURE DEW POINT



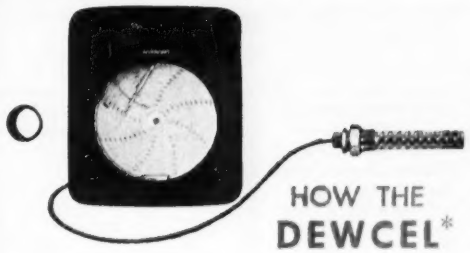
directly . . . accurately . . . continuously

Now you can measure or control the humidity content of air or process gases with simplicity and accuracy never before obtainable!

An entirely new-type humidity-sensitive element, the exclusive Foxboro Dewcel*, opens many new possibilities for product improvement in industry. Coupled with a Foxboro Recorder or Controller, the Dewcel offers these outstanding advantages:

1. Direct recording in dew point temperature, at existing pressure.
2. Wide working range — even operates at sub-zero temperatures.
3. Neither adds nor removes water from atmosphere.
4. No water box or circulation of air required.
5. Simplicity that eliminates maintenance.
6. Sustained accuracy within 1°F. to 2°F.
7. Initial and operating economy.

Investigate Foxboro Dew Point Control for your process. In successful use in nuclear fission, pharmaceutical, food and chemical plants, distilleries, photo film production, drying and storage operations. Write for Bulletin 407. **The Foxboro Company, 461 Neponset Ave., Foxboro, Mass., U.S.A.**



HOW THE DEWCEL* WORKS

The Dewcel element is a thermometer bulb (liquid-filled or electric-resistance type) jacketed with lithium-chloride-impregnated woven glass tape. Over this are wound two spaced wires connected to an AC source. The lithium chloride absorbs moisture, allowing current to flow, generating heat, and raising the temperature. Equilibrium temperature is reached when vapor-pressure of the moist salt exactly balances that of the surrounding air or gas. The System translates this temperature into direct readings of dew point.

Thus, Foxboro Dew Point Instruments give direct readings or control of dew point from —50°F. to 142°F. at working temperatures from —40°F. to 220°F. Readings easily converted to absolute or relative humidity.

*Trade Mark

RECORDING · CONTROLLING · INDICATING

FOXBORO INSTRUMENTS

FACTORIES IN THE UNITED STATES CANADA, AND ENGLAND

For more information circle **58** on inquiry card.

PALMER
MERCURY ACTUATED

DIAL THERMOMETERS

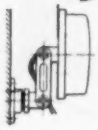
in 3 types to suit any requirements

PATENTED

Full 4½" dial face. Stem can be placed at any angle and case can be rotated to any readable position.

1 **Rigid Stem Dial Thermometer** tapered bulb, interchangeable with standard industrial thermometer separable socket. (As illustrated above.)

2 **Wall Mounted Dial Thermometer** with flexible connecting armor. Case adjustable to easy reading position.



3 **Flush Mounted Dial Thermometer** for panel mounting with flexible connecting armor.

All three types have a full 4½" dial face.

for accuracy: Mercury actuated . . . Fully Compensated by Invar Compensaton. Guaranteed Accurate 1 scale division.

for angularity: Can be adjusted to most readable position at any angle desired.

for readability: Bold Black Numbers . . . 11" of scale Reading Dial face can always be placed in easiest readable position.

for interchangeability: Always specify "PALMER" Separable sockets as they are interchangeable for Dial or Industrial type Thermometers.

Send for Bulletin 51-129 for details on the New Palmer Dial Thermometer.

PALMER
THERMOMETERS, INC.
Norwood Ave. Cincinnati 12, Ohio
Mfrs. of Industrial Laboratory Recording and Dial Thermometers

For more information circle **59** on inquiry card.

NEW INSTRUMENTS

fringes at an angular view. Available in sizes to cover optical flats with diameters of 10, 12, 14, 16 and 20 in. Operates on 110-120 v.ac.—*Acme Scientific Co.*, 1450 *West Randolph St., Chicago 7, Ill.*

For more information circle **269** on inquiry card.

Granite Surface Plate

New "Toolmakers Flat" is a black granite surface plate 8 x 12 x 2 in., weighing 15 lbs., finished to an accu-

racy of 0.0002 in. over-all.—*Collins Microflat Co., 2326 E. 8th St., Los Angeles 21, Calif.*

For more information circle **270** on inquiry card.

Soldering Machine

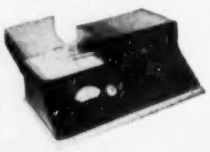
New model of maker's 250-watt "AN Connector Soldering Machine" is being made with soldering tweezers as well as regular soldering electrodes, resulting in almost universal versatility for soldering small parts on a production basis. Good air cooling being possible because of tweezers' unique design, they can be used through three shifts. Under production conditions it has been estimated that one machine with one operator can turn out work formerly produced by 2½ girls with soldering irons. The other fixed electrodes can solder from 2 to 30 terminals, and more, on AN Connectors; can also be used on terminal boards, on printed circuits with high-temperature solder that cannot be handled with a soldering iron, and for military equipment on solder-crimped lugs, to government specifications.—*Joyal Products, Inc.*, 115 *Edison Place, Newark 5, N. J.*

For more information circle **271** on inquiry card.

FOR THE TESTING DEPARTMENT

"Handle" or "Hand" Tester

New "J & J Handle-O-Meter" meets requirements of technologists as well as practical men in textile and paper industries. Maker states that although ASTM list several physical properties whose combined result is what is known as "hand" or "handle," and although each of these properties can be determined separately, there has never been a way to measure final effect until Johnson & Johnson developed "Handle-O-Meter" to fill their own needs. An electric strain gage

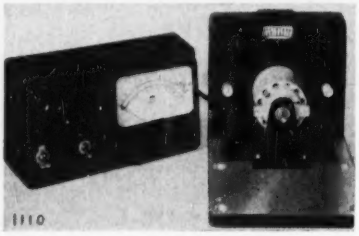


detects differences which make up final result and an electrical indicator gives numerical value. A complete test can be made in 15 seconds. —*Thwing-Albert Instrument Co., Penn St. and Pulaski Ave., Philadelphia 44, Pa.*

For more information circle **272** on inquiry card.

Eddy-current Dynamometer

New eddy-current dynamometer has two speed ranges: 0-7200 and 0-14,400 rpm., each with accuracy of 2 percent of full-scale; three torque ranges:

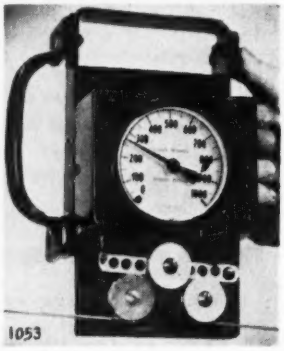


0/2/8/16 in.-oz. with respective accuracies of 8, 2 and 1 percent. New unit is suited for applications in production-line testing as well as in laboratories.—*Magtrol, Inc.*, 533 *S. Niagara, Tonawanda, N. Y.*

For more information circle **273** on inquiry card.

Tension Meter

New Tension Meter of advanced design has been added to line developed by Dr. Saxl. It is a high-capacity instrument capable of handling ten-



sions of 20 lbs. and more, as in making of wire and cables. It is available also with wider rollers for strands of rayon tow as well as for paper strips, plastic tapes, slit film, etc. A major advance over prior designs is elimination of gear trains.—*Tensitron, Inc., Harvard, Mass.*

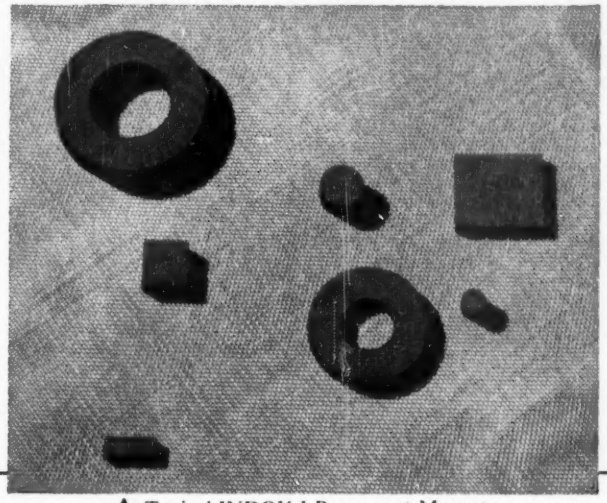
For more information circle **274** on inquiry card.

Universal Testing Machine

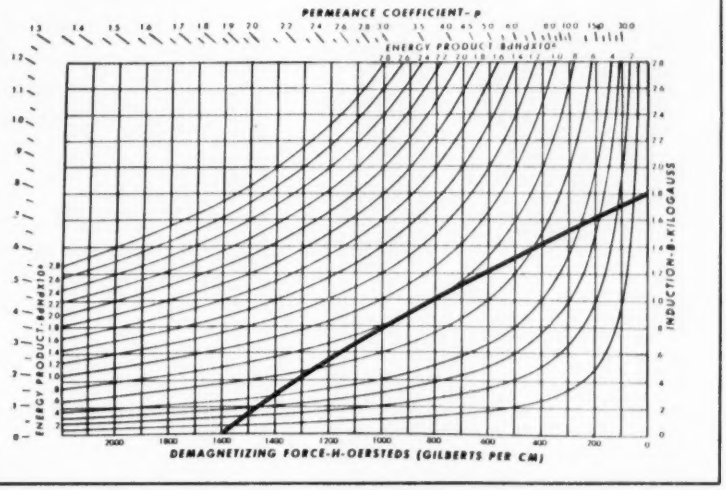
New model of maker's "Model FGT" universal testing machine utilizes two "maximum-precision-type SR-4 Load Cells" of 25,000-lb. capacity each, instead of previously-used load cells. Accuracy and sensitivity are greater than when machine was first announced in Sept. 1952. It embodies other refinements and is said to be "more truly universal than any previous universal testing machine." When equipped with suitable accessories it is capable of testing specimens of structural parts and

Presenting INDOX I... A

NEW CERAMIC PERMANENT MAGNET



▲ Typical INDOX I Permanent Magnets



▲ Demagnetization and Energy Product Curve for INDOX I

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For more information circle **60** on inquiry card.

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Koncentrik TUBE FITTINGS (in Stainless or Monel) are better FIVE WAYS

1. DOUBLE SEALED . . . metal-to-metal seal *plus* Teflon insures vacuum tight connection.

2. EASY TO USE . . . and reuse . . . install fast.

3. FATIGUE PROOF design and operation.

4. PRESSURE SAFE construction exceeds tube strength.

5. LOW INITIAL COST . . . interchangeable parts.

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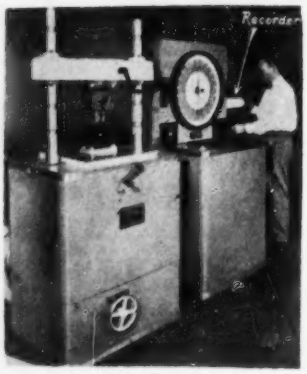
For more information circle **61** on inquiry card.

NEW INSTRUMENTS

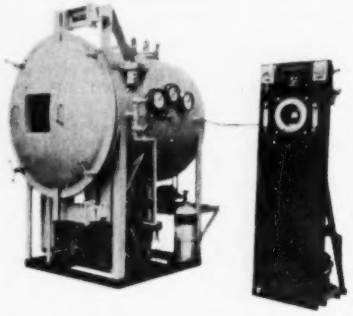


components not only in tension, compression, and flexure, but also while they are subjected automatically to alternating reversed loads, creep, stress relaxation, torsion, and shock. New "Model SRA-1" stress-strain recorder provides instant selection of magnification ratios, strain ranges and gage factors.—*Baldwin-Lima Hamilton Corp., Philadelphia 42, Pa.*

For more information circle **275** on inquiry card.

Explosion Chamber

New Explosion Chamber may be used (1) to determine effect of explosions on materials, components, sub-assemblies or completed units, or

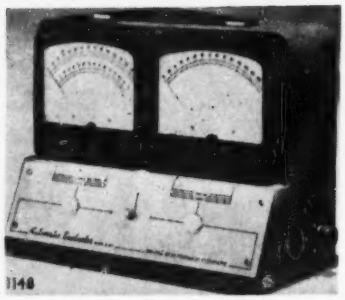


(2) to determine whether equipment will cause explosions when operated in an explosive atmosphere. It comprises (1) a cylindrical shell, (2) equipment to cause an explosion, and (3) control instruments. It can be furnished in a variety of sizes and with any auxiliary equipment desired. Standard size is 4 ft. diam. by 5 ft. long. Vacuum pump simulates altitudes to 80,000 ft. Two 100-point terminal pads good for 25 amps. at 230 volts, and two hand turning shafts, enable equipment to be operated within chamber as it would be in normal use.—*Tenney Engineering, Inc., 26 Avenue B, Newark 5, N. J.*

For more information circle **276** on inquiry card.

Automatic Evaluator for Yarn-uniformity Analyzer

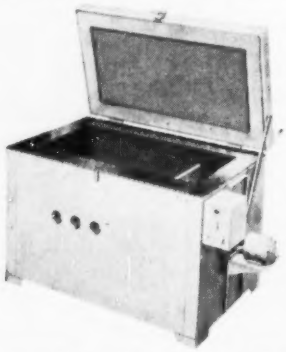
New "Model BL-814 Automatic Evaluator" is a portable, direct-reading accessory for use with maker's "Uniformity Analyzer," an instrument which records variations in weight per unit length of yarn, roving and sliver. New accessory indicates the same average peak-to-peak readings that otherwise would be obtained from chart calculations. Hence, direct correlation between data obtained from both chart and "Automatic Evaluator," and showing of defects in material which might be averaged out in area-reading devices. —*Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio.*



For more information circle **277** on inquiry card.

Temperature Test Chambers

New high-low temperature chambers for evaluating characteristics of aircraft components, etc., have a temperature range of –100 F. to 300

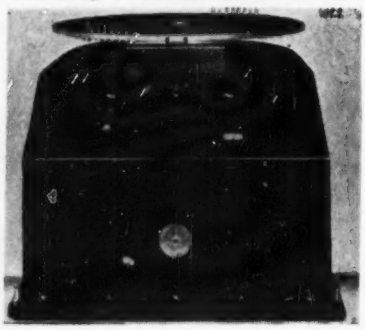


F.; stainless steel interior; 5½-in. glass wool insulation; full-opening counterbalanced lid; usable working volume of approx. 12 cu. ft.; dual thermostats for high and low temperature control. Units use block dry ice as a refrigerant.—*Dept. I, Mantec Inc., El Segundo, Calif.*

For more information circle **278** on inquiry card.

Rate-of-turn Table

New "Model C Rate-of-Turn Table," for calibrating and evaluating rate gyros, and for calibrating accelerometers up to 10 *G*, features a new



115-v.ac. 180-rpm. synchronous motor designed specifically for this low-speed application, with extremely smooth operation by virtue of high rotational inertia, and electrodynamic braking. Rotor is energized with d.c. in synchronous-run condition and resulting torque is in excess of 50 in.-lbs. Output from constant-speed motor to 24-in. cast aluminum table is infinitely variable through a ball-disk integrator drive from 0.01 to 1200 deg./sec. Speed indicator drum is augmented by a line-frequency strobe light focused on engraved rim of table. (Stroboscopic harmonics are accurate to within 0.1 percent in most parts of U. S.) Table capacity 100 lbs.—*Genisco, Inc.*, 2233 *Federal Ave., Los Angeles* 64, *Calif.*

For more information circle **279** on inquiry card.

Accelerometer Calibrator

New "Model 200 Portable Accelerometer Calibrator" makes it possible to calibrate entire accelerometer-recorder system in the field immediately prior to recording. Several accelerometer pickups can be screwed to table of calibrator, which may be set for 5, 10, or 20 *G* peak acceleration amplitudes. Weight of calibrator is less than 15 lbs.; dimensions approx. 6x6x15 in.—*VibraShock Corp.*, 5232 *River Road, Washington* 16, *D. C.*

For more information circle **280** on inquiry card.

Tube Tester

New "Model 981 Type 2" is a tube-checker of proportional mutual conductance type for both production tests and troubleshooting, claimed to

provide "greater accuracy and new time-saving facility in testing all tube types," It measures proportional mutual conductances, emission characteristics of rectifiers and diodes, and firing potential limits of voltage regulators and low power thyratrons. An outstanding feature is provision for accurate measurement of leakage resistance, as high as 5 megohms, between tube elements; also transconductance up to 24,000 micromhos in four ranges with selector switch.—*Weston Electrical Instrument Corp.*, 614 *Frelinghuysen Ave., Newark* 5, *N. J.*

For more information circle **281** on inquiry card.

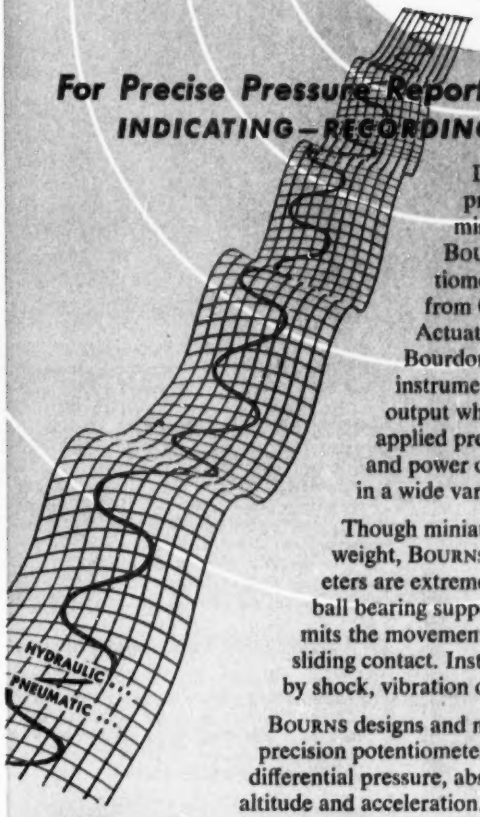
Continuity Testers

New "Model AP-101-A1 Troubletracker" utilizes a selenium rectifier and filter in its circuit so that it can detect capacitors which are open or shorted, and trace continuity of circuits through high (or low) resistance elements. Touching probes to circuit

BOURNS

MINIATURE
GAGE PRESSURE
POTENTIOMETERS

For Precise Pressure Reporting...
INDICATING—RECORDING—CONTROL



Designed for measuring pressure in aircraft, guided missiles and other equipment, BOURNS Gage Pressure Potentiometers are available in ranges from 0-100 psi to 0-5,000 psi. Actuated by the flexure of a Bourdon tube, these precision instruments have an electrical output which is linear with the applied pressure. Resolution of 0.4% and power of ½ watt are obtainable in a wide variety of resistances.

Though miniature in size and light in weight, BOURNS Gage Pressure Potentiometers are extremely rugged and accurate. A ball bearing supported linkage system transmits the movement of the Bourdon tube to the sliding contact. Instruments are not damaged by shock, vibration or nominal over-pressure.

BOURNS designs and manufactures other precision potentiometers for measuring position, differential pressure, absolute pressure, altitude and acceleration.

BOURNS is also the creator and exclusive manufacturer of the TRIMPOT.

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Technical Bulletin on request, Dept. 23

For more information circle **62** on inquiry card.

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The *only* portable machine which reproduces *15* sizes from *one* master alphabet.

The *only* one with *adjustable* copy holding slides for multiline engraving in one set-up.

Self-centering holding vise for nameplates

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For more information circle **63** on inquiry card.

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TECH-PEN produces sharp, rub-proof markings on slides, test panels, instruments — *anything!* And those markings are quick-drying, permanent, yet removable with common solvents.

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With each TECH-PEN, you get an extra ink supply good for 25,000 markings; choose from red, green, yellow, blue, black or white.

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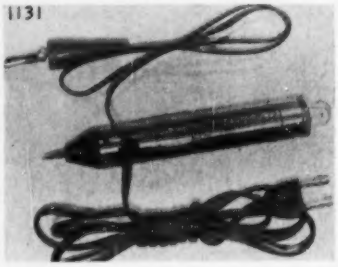
For more information circle **64** on inquiry card.

NEW INSTRUMENTS

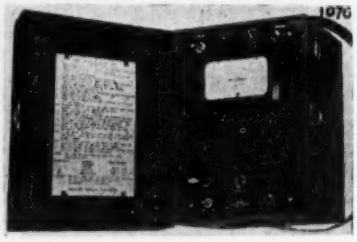


causes a current of less than 0.5 ma. to flow, making neon bulb at end of tester glow when circuit is continuous. ★"Model AP-100-A1 Continuity Tester" operates on a single flashlight battery, is designed especially for the industrial electrician; is made of aluminum and plastic; is 3.5 in. long. —*Revan Products Co., Box* 549, *Binghampton, N. Y.*

For more information circle **282** on inquiry card.

Insulation Tester

New "Model 272 Vibrotest" is a heavy-duty portable insulation resistance tester featuring nine ranges of resistance values from 0.1 to 50,000



megohms at d.c. test potentials of 500, 1250 and 2500 v. Output test voltage on all ranges is regulated at 0.1 percent. Selector switch has "Quick Charge" position bypassing output resistor to make full 4-ma. output available to more quickly charge highly capacitive circuits, reduces time necessary to obtain readings. After reading, operator is protected from any capacitive discharge from test circuit. —*Associated Research, Inc.*, 3766 *W. Belmont Ave., Chicago* 18, *Ill.*

For more information circle **283** on inquiry card.

Stand for Test-instruments

New "Model 901 Tek-Stand" has arms clamped to upright member and firmly attached to backs of instrument cabinets, allowing adjustment to any position or angle. Up to three "A" size cabinets (illustrated) may be

mounted on a single stand. Multiple outlets are provided in base for power cords of instruments.—*Shasta Div., Beckman Instruments, Inc., P.O. Box* 296, *Sta. A., Richmond, Calif.*

For more information circle **284** on inquiry card.

Automatic Cable Tester

New "Model 4110 Cable Tester" automatically scans multiconductor cables and prints on standard adding machine tape a code number of those connections not meeting preselected

values of continuity and leakage. By means of stepping switches, leads are sequentially scanned according to any predetermined pattern. Code numbers, representing discrepancies found, are printed on adding machine tape which may then be affixed to cable. "No. 4110" has cut testing time on a 32-pin cable from 1 hr. to 4 min. per cable. By use of adaptor sockets, it can be used with a wide variety of cable-terminating connectors. Its complete circuit can be checked for proper operation in a few seconds by means of a test switch located on front panel.—*Berkeley Scientific, Div., Beckman Instruments, Inc.*, 2200 *Wright Ave., Richmond, Calif.*

For more information circle **285** on inquiry card.

Automatic Tester for Electrical Components

New "Supertester" permits production-line testing at the rate of several checks per second; has facilities for as many as 400 individual automatic sequenced tests, distributed among six basic types: continuity, leakage, d-c. voltage, a-c. voltage, resistance, and impedance. Derivative characteristics such as gain, frequency response, phase relationships, and noise levels are determined through combination of two or more standard tests. Provisions are included for manual dialing to any one test; and for utilizing accessory signal generators, dropping resistors, etc., to permit tests at frequencies or voltages outside scope of standard instrument. Master cabinet (at bottom in illustration) contains basic switching units

New! VARY-TALLY

Multiple-Unit Reset Counter

DESIGNED TO COUNT ANYTHING COUNTABLE

this new Vary-Tally can be supplied in any combination up to 6 banks high, 12 units wide, with the counting units arranged compactly on stands in tiers. Now check these special features of Veeder-Root design and construction:

- Easily Readable from any Angle . . . Bold Figures Always Centered in Window . . . No Glare . . . Figures not Covered by Fingers in Operation
- Easily Portable, yet Ruggedly Built for Long Wear
- Separate Counting Units Can be Rotated like Tires on a Car, to Distribute Wear Evenly
- All Parts Corrosion-Resistant
- Working Parts of Hardened Steel
- Operation Not Affected by Extreme Heat or Cold
- Individual Tag Above Each Counter-Window — Not Strip Tabs
- Veeder-Root Quality in Every Part

Now what's on *your* mind, that Vary-Tally can help you count? Write for news sheet and prices.

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For more information circle 65 on inquiry card.

the Waterman TWIN POCKETSCOPE®

MODEL S-15-A

Size:
12" x 6" x 7"
16¼ Pounds

ANOTHER EXAMPLE OF Waterman PIONEERING...

The WATERMAN TWIN POCKETSCOPE, model S-15-A, presents a new concept in multiple trace oscilloscopy with independent vertical channels each having a sensitivity of 10 millivolts rms/inch, and a response within —2 db from DC to 200 KC—a pulse rise time of 3 microseconds. These features combined with the provisions for intensity modulating either, or both, traces, results in greater flexibility. The sweep generator is operated either in the repetitive or triggered mode from 0.5 cycles to 50 KC with synchronization polarity optional. All attenuators and gain controls are of the non-frequency discriminating type. Remember that portability has not been overlooked! The amazing small size of the S-15-A tips the scales of opinion heavily in its favor. Imagine, all of these essential characteristics in an instrument weighing only 16¼ lbs. You can carry it to any job, anywhere!

WATERMAN PRODUCTS CO., INC.
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CABLE ADDRESS: POKETSCOPE

MEMO... Write for details today!

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S-4-A	SAR	PULSESCOPE®
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S-11-A	INDUSTRIAL	POCKETSCOPE
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Also RAYONIC® Cathode Ray Tubes and Other Associated Equipment

WATERMAN PRODUCTS

For more information circle **66** on inquiry card.

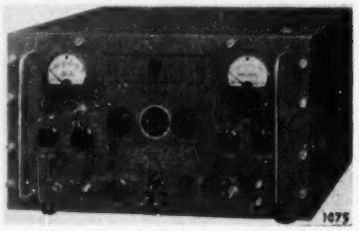
NEW INSTRUMENTS

and measuring circuits: no internal changes or adjustments required for any test sequence. Adapters, plugged into top of master unit, are individually laid out and wired for each type of component under test. In operation, attendant attaches adapter leads to equipment to be tested and presses starter button. Instrument proceeds through sequence of tests, sounding an alarm on discovery of a fault, on reaching a test which requires a product adjustment, and on reaching end of entire test sequence. Like all standard tests, adjustment step can be made on a go/no-go basis with attendant not required to measure or even understand the particular adjustment.—*Color Television Inc., 952 San Carlos Ave., San Carlos, Calif.*

For more information circle **286** on inquiry card.

Signal Generator for ILS

New "Type 232-A Glide Slope Signal Generator" provides, for the first time in a single self-contained instrument, complete testing and calibration facili-



ties for glide slope receiving equipment as used in CAA Instrument Landing System.—*Boonton Radio Corp., Boonton, N. J.*

For more information circle **287** on inquiry card.

SHF Test Oscillator

New "Model 1180" combines broadband frequency range with portability, compactness, and delivers a minimum of 200 microvolts into 50 ohms over frequency range of 3.00 to 11.00 kMc. pulsed at 800 pps. Cavity is excited by a spark generator energized by self-contained batteries. A waveguide beyond-cutoff attenuator provides 100 db of attenuation. A broadband antenna and cable are provided for complete radar, microwave relay, etc. system checks. Total weight is less than 12 lbs.—*Seabord Electric Co., 417 Canal St., New York 13, N. Y.*

For more information circle **288** on inquiry card.

Signal Generator

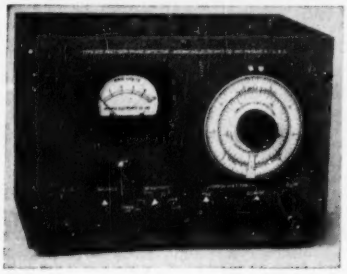
New "WR-49A" radio-frequency signal generator, useful as a TV and radio signal tracer as well as an alignment oscillator and marker generator, is specifically designed for a wide range of AM radio, FM radio, and TV service operations and other applications which require a continuous wave or modulated rf signal of sinoidal waveform from 85 kc. to 30 Mc.—*Tube Dep't., RCA Victor Div., Radio Corporation of America, Camden, N. J.*

For more information circle **289** on inquiry card.

ELECTRICAL INSTRUMENTS

Phase-angle Meter

New "Type 205 Precision Phase Detector" features accuracy of 0.1 degree; range 10 kc. to 10 Mc. It comprises two cathode followers, a con-

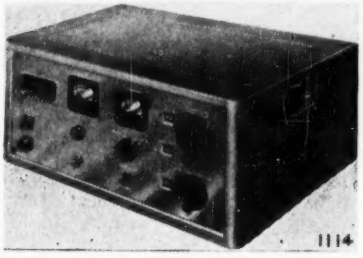


tinuously variable delay line, a balanced phase detector, and a sensitive output indicator. Continuously-variable delay line is used to delay unknown signal in order that reading on output indicator becomes zero or minimum. Unknown phase angle is read on dial of continuously-variable delay line in degrees. Lower frequency limit may be extended to 1 kc. with an additional delay line or phase-shifting network; upper limit may be extended with relaxing accuracy.—*Advance Electronics Co., P. O. Box* 394, *Passaic, N. J.*

For more information circle **290** on inquiry card.

UHF Wideband Oscillator

New "UHF Wide Band Power Oscillator" for use in antenna radiation, antenna field strength, wave-filter, noise and interference measurements,



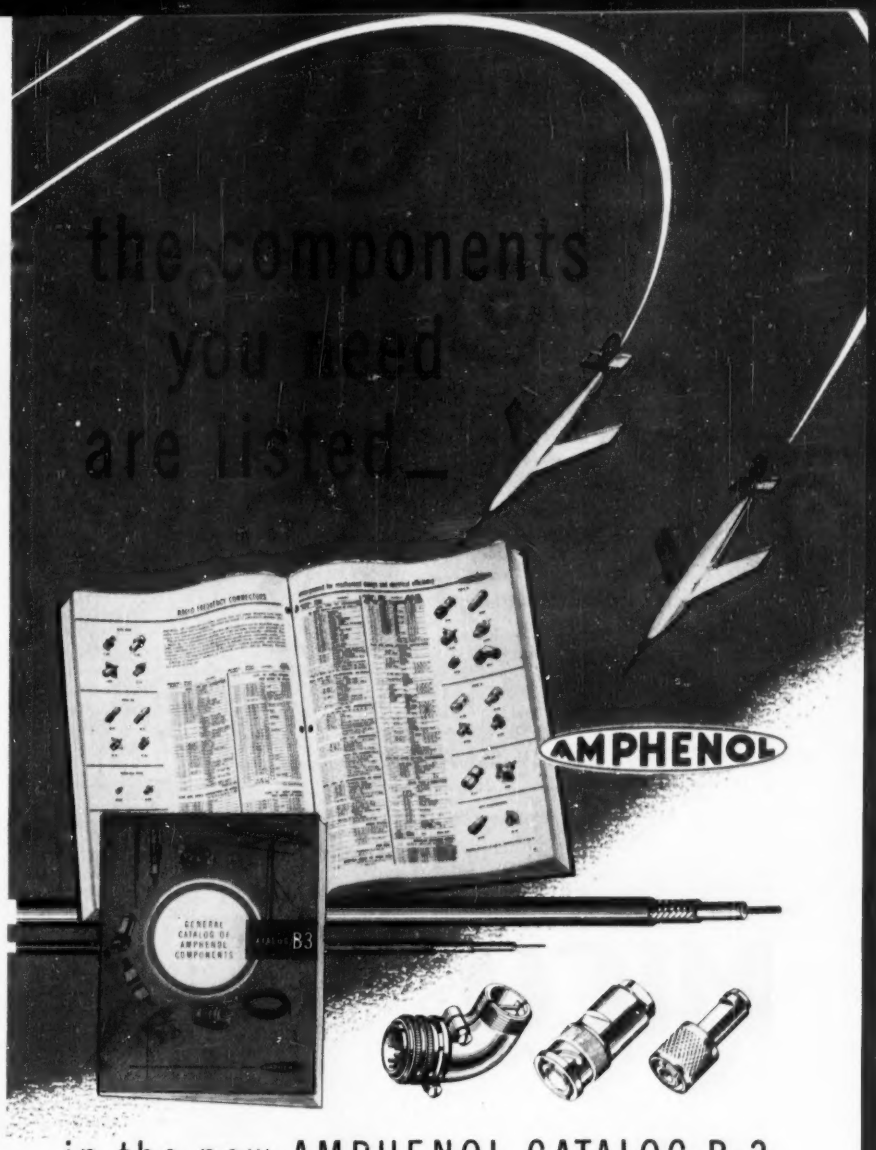
is adaptable also as a general-purpose low-power portable transmitter and in production testing and measurement of UHF equipment. Features: continuous frequency coverage from 200 to 2500 Mc.; output power from 50 w. to 200 Mc. to 10 w. at 2500 Mc.; continuous output monitoring and external modulation. Grid-separation dual-cavity coaxial-line oscillator permits single tuning control setting of plate and grid circuit line lengths.—*W. L. Maxson Corp.*, 460 *W. 34th St., New York* 1, *N. Y.*

For more information circle **291** on inquiry card.

Waveform Analyzer

New "Sonic Analyzer LP-1" is a scanning heterodyne type instrument that automatically separates frequency components of a complex audio wave and simultaneously meas-

Circle **67** on inquiry card. ⟶



in the new AMPHENOL CATALOG B-3

The new AMPHENOL B-3 catalog has just been released. The B-3 is designed to give general information about the entire AMPHENOL line of quality components—AN connectors, RF connectors, coaxial cables, sockets—everything made by AMPHENOL is concisely described and illustrated. From the B-3 you will be able to choose the components you need for quality electronic equipment.

At AMPHENOL there is a constant concern with quality. In design, engineering and production this AMPHENOL *emphasis on quality* produces quality components for the electronics industry. New ideas are a major AMPHENOL contribution to electronics. Connectors and cables with application possibilities thought impossible a few years ago are made by AMPHENOL today.

The B-3 catalog also gives a complete listing of special catalogs and bulletins that will prove of value where more specific information is required on AMPHENOL components.

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For more information circle **68** on inquiry card.

MICO

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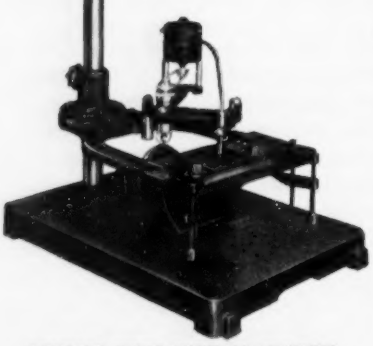

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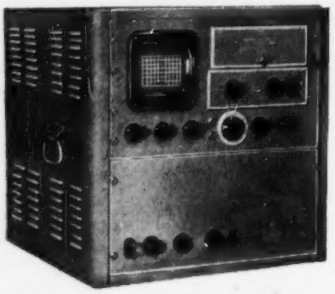
For more information circle **69** on inquiry card.

NEW INSTRUMENTS

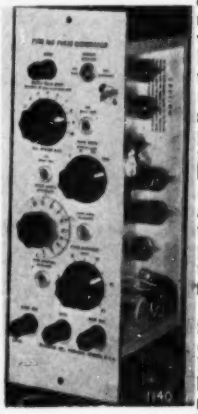


ures their frequency and magnitude; is recommended when necessary to resolve components closely spaced in frequency. Automatic high-speed sampling and visual presentation of audio spectrum enables observation of changes in energy distribution either while waveform itself varies in a random manner or while design constants are altered. It allows rapid measurement of individual distortion components rather than total distortion alone; eliminates point-by-point frequency and amplitude measurements.—*Panoramic Radio Products, Inc., 10-16 S. Second Ave., Mount Vernon, N. Y.*

For more information circle **292** on inquiry card.

Fast-rise Pulse Generator

New "Type 163," added to "Type 160 Series" of special waveform generators, supplies rectangular pulses

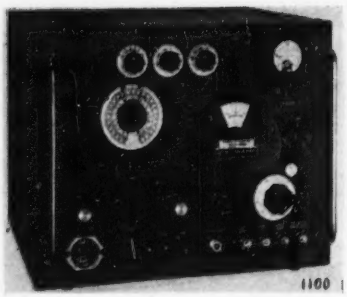


of less than 0.2-usec. risetime when triggered by either a positive pulse or a negative-going sawtooth. It supplies a positive pulse of calibrated continuously-variable amplitude from 0 to 25 v. peak-to-peak, and a positive gate of 25 v. fixed amplitude (pulse and gate identical in other characteristics. Duration is calibrated and is continuously variable from 1 usec. to 10,000 usec. When triggered by a sawtooth voltage, output may be delayed a calibrated interval from 0 to 100 percent of sawtooth duration. Decay time is 0.2 usec.; overshoot can be adjusted to zero.—*Tektronix, Inc., P. O. Box 831, Portland 7, Oregon.*

For more information circle **293** on inquiry card.

Direct-reading 7-11-kMc. Signal Generator

New "Model 620A" signal generator offers direct frequency setting and readings from 7 to 11 kMc.; simplifies all SHF measurements including sensitivity, selectivity, and rejection, signal-to-noise ratio, conversion gain, swr., antenna gain and transmission line characteristics; may also be used for slotted lines, waveguide and filter

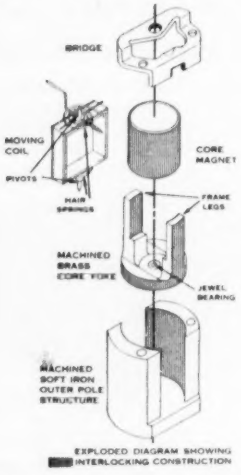


networks. Broad selection of pulsing capabilities: internal or external pulse modulation, internal square-wave modulation, frequency modulation and cw. output. Pulse output width variable from 0.5 to 10 usec. and repetition rate is 40 to 4,000 pps. On internal FM, saw-tooth sweep variable between 40 and 4,000 cps. For external FM, capacitive coupling to repellor of klystron oscillator; repellor voltage tracked automatically, no adjustment needed to select correct frequency.—*Hewlett-Packard Co., 395 Page Mill Rd, Palo Alto, Calif.*

For more information circle **294** on inquiry card.

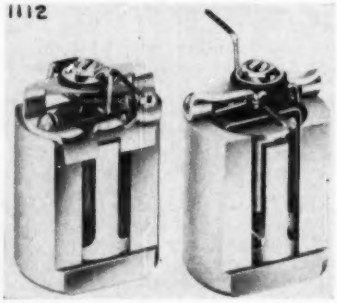
Electrical Indicating Instruments

New deflection-type instruments feature a coaxial assembly said to represent "a new concept in the design of the moving-coil galvanometer



EXPLODED DIAGRAM SHOWING INTERLOCKING CONSTRUCTION

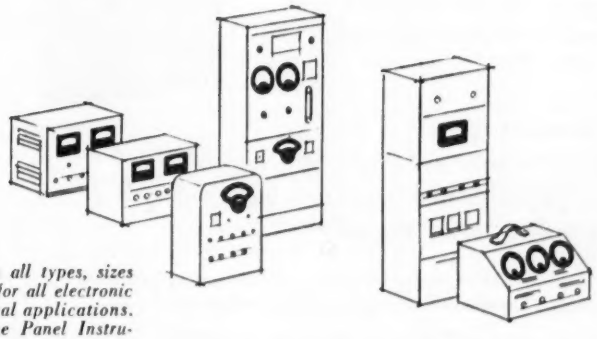
mechanism" with exceptionally small size and weight (0.8 oz.). Drawings and photographs herewith show all parts except the two bridge screws (which are the only fastenings in en-



WESTON

PANEL INSTRUMENTS...

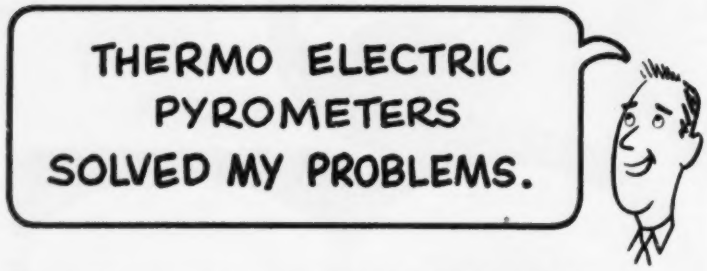
...outward evidence of the high quality built within fine electronic equipment



Available in all types, sizes and ranges for all electronic and electrical applications. Send for the Panel Instrument bulletin.

WESTON ELECTRICAL INSTRUMENT CORPORATION, 614 Frelinghuysen Avenue, Newark 5, N. J.

For more information circle **70** on inquiry card.



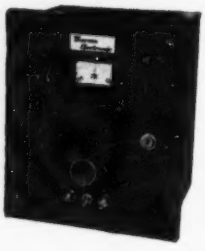
Thermo Electric makes many products that help solve problems in the field of temperature measurement and control. T-E controllers and indicating-recorders are good examples. They are both made in two types: potentiometer pyrometer and resistance thermometer. They are accurate (±¼ of 1% of the range), rugged, simple in design, easy to maintain. Ranges from −100° — +600°F up to 0 — 3000°F.

THERMO ELECTRONIC INDICATING-RECORDER

Only three moving parts in the recording system—pen arm is driven from a cam, which permits linear charts to be used for all temperature measurements —full scale pen travel only 4 seconds. Easily adapted to measure humidity, solution conductivity, speed, pH, direct current, DC voltage, or other variables.

THERMO ELECTRONIC CONTROLLER

Two-position control action is continuous and instantaneous — potentiometer pyrometer type is sensitive to changes of as little as ±1.5°F, or less; resistance thermometer type is sensitive to changes of as little as ±0.1°F.



Write for details:

controller, potentiometer pyrometer type, bulletin 50—F
controller, resistance thermometer type, bulletin 55—F
indicating-recorder, both types, bulletin 60 —F

Pyrometers • Thermocouples • Protection Tubes • Quick-Coupling Connectors Thermocouple and Extension Wires • Resistance Bulbs • Connector Panels

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For more information circle **71** on inquiry card.

tire assembly). Critical dimensions being machined from a common center, alignment is better than with stamped parts, and rigidity-to-weight ratio is higher than possible with conventional mechanisms.—*Marion Electrical Instrument Co., Manchester, N. H.*

For more information circle **295** on inquiry card.

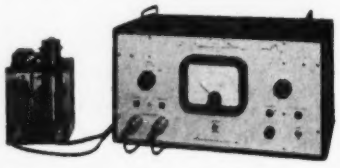
UHF Sweep Generator for Industrial Uses

New "Model G-8010 High Output Constant Level UHF Sweep Generator" is designed for industrial uses in UHF sweep alignment, production-line testing, laboratory development work, alignment and evaluation of UHF converters, and as a signal source for antenna measurements. Each unit is hand calibrated. Among features: extremely high output—a minimum of one volt peak-to-peak (blanked); extreme flatness of sweep (±1 db over entire frequency range of 470-890 Mc.); exclusive leveling circuit designed to reduce errors of matching that might be introduced by input circuit of unit under test.—*Philco Corp., Accessory Div., "A" & Allegheny Avenue, Philadelphia, Pa.*

For more information circle **296** on inquiry card.

Vibrating-reed Electrometer

New "Vibrating-reed Electrometer" is a line-operated instrument for measurement of small currents and voltages, utilizing a vibrating-reed



capacitor of extremely high input impedance (10^{16} ohms) to convert d-c. signal to a.c. which is then amplified and fed to phase-sensitive rectifier. Full-scale deflection ranges 1, 10, 100 mv. and 1v.; accuracy 1 percent on all ranges; drift less than 100 microvolts per day.—*Dep't. IM, Marconi Instruments, Ltd., 23/25 Beaver St., New York 4, N. Y.*

For more information circle **297** on inquiry card.

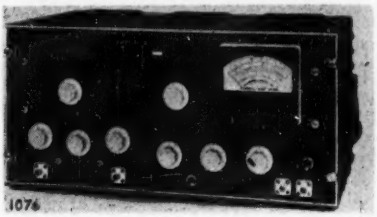
Field Intensity Meter and Test Set

New "BW-7A" combines in one instrument a field intensity meter said to be "more accurate and more convenient to use than any previously available," a standard signal generator of laboratory quality, and a laboratory quality receiver continuously tunable from 54 to 230 Mc. It is suitable for AM, FM and all TV measurement use, as well as for frequencies between 50 and 220 Mc. assigned to aeronautical and other public services. Complete with carrying case, dipole and tripod antennas and necessary cables, equipment weighs 47.5 lbs.; operates from either a 6-v. battery or 110-v.ac. supply.—*RCA Victor Div., Camden, N. J.*

For more information circle **298** on inquiry card.

SWR Amplifier

New "Model TAA-16B," for determining standing wave ratios or comparison of any two demodulated signals, incorporates all features of

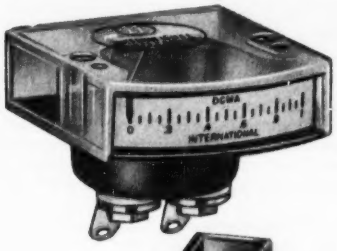


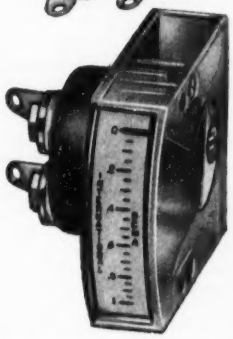
former "Models TAA-16" and "TAA-16A" and provides additional features and conveniences at less cost than previous models. It has dual input channels with gain sufficient for full-scale deflection with less than 2 microvolts input; may be used broadband from 500 to 5000 cps. or may be sharply tuned over this range by means of panel controls. For use with bolometers, an internal voltage source is supplied and bolometer current for either input is metered and adjustable from front panel.—*Browning Laboratories, Inc., Winchester, Mass.*

For more information circle **299** on inquiry card.

Edgewise Indicating Instruments

New miniature "Model 1120 Side Indicating Panel Meters" are available in many ranges; zero center, left or





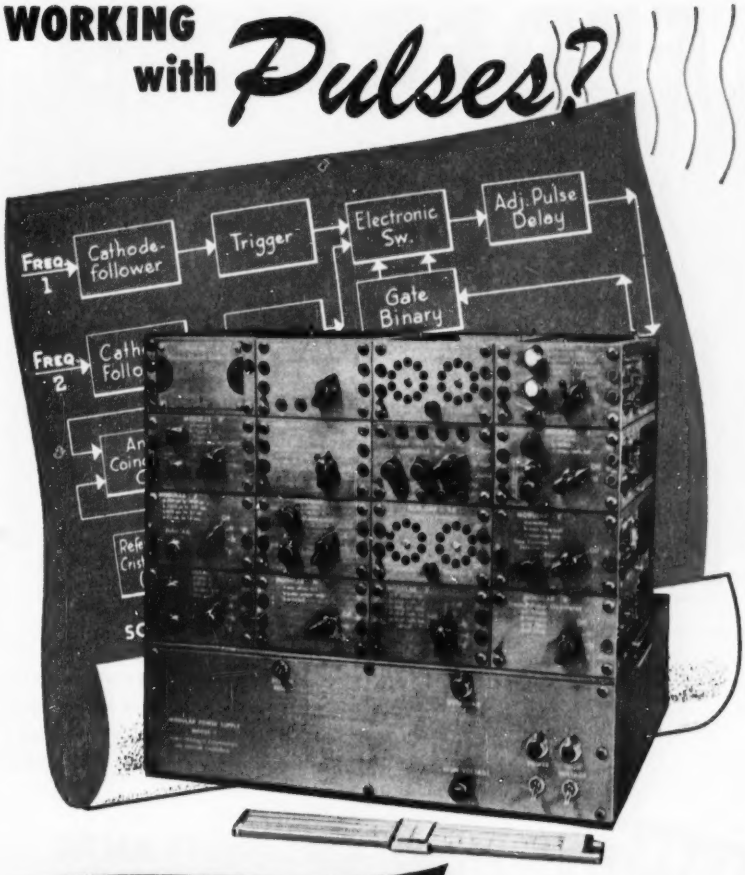
right. Accuracy: 3 percent of full-scale on d.c. and 5 percent on a.c.—*International Instruments, Inc., P. O. Box 2954, New Haven 15, Conn.*

For more information circle **300** on inquiry card.

Low-frequency Oscillator

New "Model 420-C" for applications requiring sine-wave and square-wave voltages in frequency range of 0.35 to 52,000 cps., features special circuits to eliminate transients after tuning or band-switching. Maximum output

WORKING with *Pulses?*



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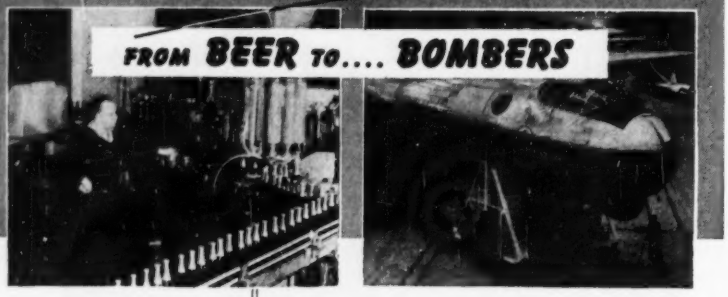

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For more information circle **73** on inquiry card.

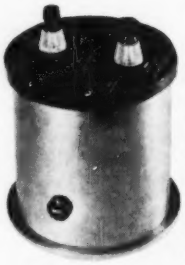
NEW INSTRUMENTS

is 30 v. peak-to-peak across a 1,000-ohm load. Other features: good amplitude constancy; hum and distortion maintained at a constant low percentage of output signal.—*Krohn-Hite Instrument Co.*, 580 *Massachusetts Ave., Cambridge* 39, *Mass.*

For more information circle **301** on inquiry card.

ELECTRICAL-INSTRUMENT ACCESSORIES

Peak Voltmeter Converters



New "Peak Voltmeter Units" convert any of maker's rms-reading electrostatic voltmeters into an accurate peak-reading voltmeter which draws negligible power from circuit under measurement. New units not only rectify measured voltage but store peak value. They are rated in inverse peak volts; are normally supplied for "positive" peaks (for "negative" peaks on special order).—*Sensitive Research Instrument Corp.*, 9-11 *Elm Ave., Mount Vernon, N. Y.*

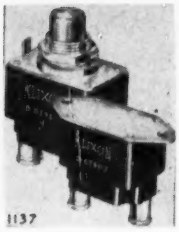
For more information circle **302** on inquiry card.

Variable Autotransformer

New "Type 300BU Adjust-A-Volt" variable autotransformer features: (1) a new-design factory-preadjusted brush assembly which maintains almost constant pressure from full-brush to no-brush, assuring longer and more reliable operation; (2) direct electrical connection between brush and current take-off point of brush assembly. "Type 300BU" is said to be "ideal for built-in applications such as line voltage control for power supplies and instruments, control of oven heat, motor speeds, etc." Maximum load rating 400 va. available in single or ganged assemblies.—*Standard Electrical Products Co.*, 2240 *E. Third St., Dayton, Ohio.*

For more information circle **303** on inquiry card.

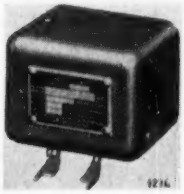
Circuit Breakers for Instrument Protection



New "D6755-1 and D6756-1 Klixon Circuit Breakers", in ratings of 0.5, 0.75 and 1 amp., are completely sealed; were designed for protection of power supply in aircraft instrument circuits. "D-6755-1" is manual-reset non-indicating type; "D6756-1" is automatic-reset version. Actuator is maker's snap-acting disk which provides a positive make and break. Units will withstand a shock of over 25 *G* and a vibration frequency of 10 to 55 cps. with a total excursion of 0.06 in. —*Spencer Thermostat Div., Metals and Controls Corp., Attleboro, Mass.*

For more information circle **304** on inquiry card.

Inductors

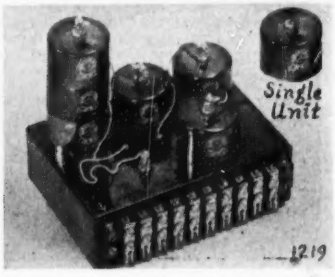


New "Type 590-A" inductors, designed for use in *Q* circuit of maker's "Type 170-A and Type 190-A *Q* Meters," are available in six types, for measuring RF characteristics of capacitors, resistors, and insulating materials over a frequency range of 20 to 230 Mc.; also have general usefulness as reference coils and can be used to periodically check performance of *Q* Meters. —*Boonton Radio Corp., Boonton, N. J.*

For more information circle **305** on inquiry card.

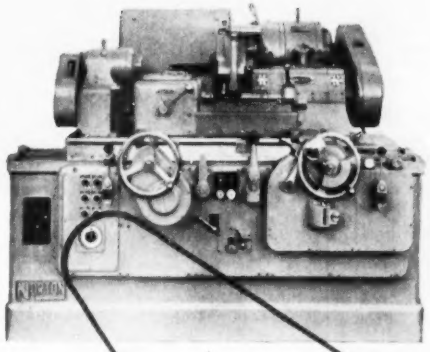
Decade Inductors

New decade inductors are toroids combined in plug-in decade steps. Among claimed advantages are elimination of inter-wiring and selector switch capacitances; simplicity of service and replaceability of individual units; more than one simultaneous setup with a given set of coils. Guaranteed tolerance is 1 percent of marked inductance value. One basic set of four decade units will provide inductance values in decade steps of 1 to 10 by use of 1-2-3-4 system. By including eight-unit coil in basic set it becomes unnecessary to employ more than two coils for any decade value up to 12, and this extends range to 18 for five coils. Two series of plug-in decade units are available



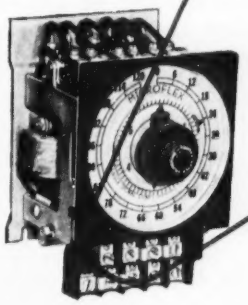
EAGLE "AUTOMATISM"

INCREASES PROFIT OF CYLINDRICAL GRINDING



NORTON 6 x 18" TYPE CTU SEMI AUTOMATIC CYLINDRICAL GRINDING MACHINE

YOU CAN INCREASE PROFIT IN YOUR INDUSTRIAL APPLICATION



The new Norton Machine shown above, greatly increases profit in its' operation of cylindrical grinding. This machine incorporates an Eagle Microflex Timer for accurate, time control. Eagle manufactures a timer for your application or a complete control panel to automatically control your entire process. Increase your profit, send your problem to Eagle today.

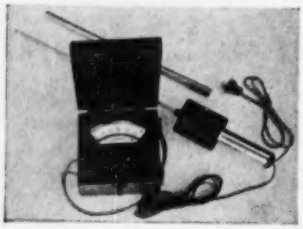
EAGLE TIMERS WILL MAKE YOUR MACHINES AUTOMATIC

EAGLE SIGNAL Industrial Timers

EAGLE SIGNAL CORPORATION MOLINE, ILL.

For more information circle **74** on inquiry card.

RAWSON-LUSH
Rotating Coil
GAUSSMETER



Tiny coil (approx. 3 mm diameter) rotates in the field to be measured. The voltage generated is rectified in a synchronous rectifier and used to deflect a Rawson high sensitivity voltmeter with scale calibrated in kilogausses.

Features

(1) Simple operating principles, simple to use and maintain.
(2) Compact and portable, just one meter and the long probe unit.
(3) Ranges 0.4—1.2—4—12—40—120 kilogausses, all in one instrument.
(4) Practically point measurement of magnetic field.
(5) Can be inserted in any gap larger than ¼" and will reach center of 37" diameter gap. Coil protected by stationary outer tubing.
(6) Measures direction of field as well as intensity.
(7) Guaranteed accuracy 1 per cent or better.
(8) Low Price $350.00 complete with meter.

RAWSON ELECTRICAL INSTRUMENT COMPANY
112 Potter St. Cambridge, Mass.

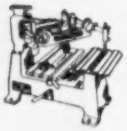
For more information circle **75** on inquiry card.

PREIS
ENGRAVING
MACHINES & Accessories

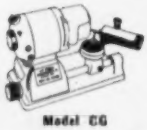
Designed for fast-easy engraving, etching and electric marking of lettering, design, calibrating and numbering on parts and instruments of any metal, plastic or other material.

Model 2D-4

Model UE-3



You're always safe in buying PREIS-*PANTO engraving machines and accessories.



Model CG

Model CG for single lip engraving and routing cutter grinding.

PREIS-*PANTO CUTTERS and COLLETS single lip, straight or tapered.

Write for new color folder of the entire PREIS-*PANTO line.

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*TRADE MARK Reg. U. S. Pat. Off.

H. P. PREIS
ENGRAVING MACHINE CO.
661 U. S. Highway 22 Hillside, N. J.

For more information circle **76** on inquiry card.

NEW INSTRUMENTS

over inductance range of 1 millihenry to 180 henries: one series has useful frequency range of 100 cps. to 10 kc. (for lower inductance values); another series 2 to 50 kc.—*Burnell & Co., 45 Warburton Ave., Yonkers 2, N. Y.*

For more information circle **306** on inquiry card.

Wide-range R-f. Inductor

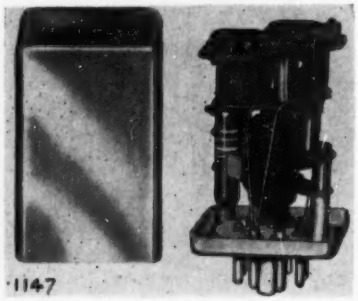
New "Type 6XBK2," added to maker's line of "Increductor" controllable inductors, contains four current-controlled signal windings or

bands, with a single control winding. It provides for an electronic sweep between 4 and 220 Mc. all on fundamental frequencies. It is readily adaptable in sweep oscillators providing a wide frequency range, electronically and remotely controlled, with no moving parts. Band inductances from 25 microhenries down to 0.07 microhenry. A Colpitts oscillator circuit utilizing a 12AT7 is recommended. Starting frequency within each band may be set with a 75 $\mu\mu$f dual capacitor.—*CGS Laboratories, Inc., 391 Ludlow St., Stamford, Conn.*

For more information circle **307** on inquiry card.

Frequency Stabilizers

New "Frahm Oscillator Controls" are miniature tuning forks for use in electronic oscillators to provide stable output frequencies. By their use, it

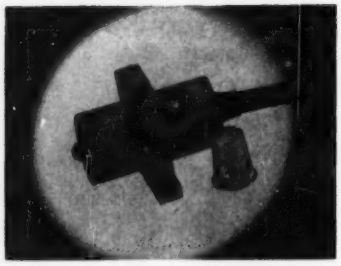


is said, good sine-wave signals with output better than 1 volt can be obtained. They are available for any frequency in the range 50 to 1000 cps. with accuracies in the order of 0.1 percent. A series of standard units is available to match maker's standard "Frahm Reed Relays."—*James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa.*

For more information circle **308** on inquiry card.

Cathode Follower

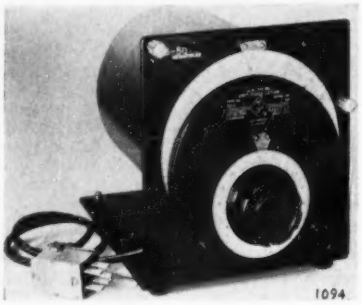
New "Model 2608 Subminiature Cathode Follower" for impedance transformation permits vibration and shock area location of electronic equipment associated with high-impedance instruments. Small size permits installation in cramped quarters. Input impedance of over 100 megohms was designed because only short lengths of high-impedance cable are then required when used with maker's "Series 2200" pickups.—*Endevco Corp., c/o Wright Engineering Co., 180 E. California St., Pasadena 1, Calif.*



For more information circle **309** on inquiry card.

Unit Oscillator

New "Type 1211-A Unit Oscillator" has frequency span of 0.5 to 50 Mc., covered in two 10-to-1 logarithmic ranges. Frequency is read directly

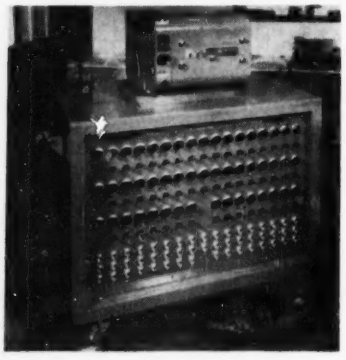


from a 6-in. dial, with a slow-motion-drive dial indicating frequency increments of 0.2 percent per division. Output power is well over one watt over 0.5-to-5 Mc. range and at least 0.2 watt over 5-to-50 Mc. range. Construction provides effective shielding so that instrument can be used as a power source in bridge measurements.—*General Radio Co., 275 Massachusetts Ave., Cambridge, Mass.*

For more information circle **310** on inquiry card.

Oscillograph Control Unit

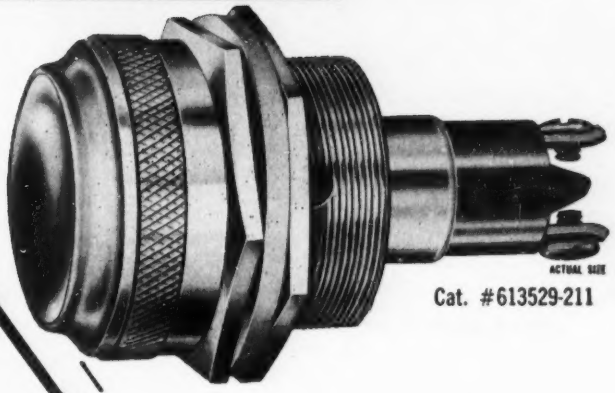
New "Mobile Oscillograph Control Unit" provides a convenient means for applying signals to any string galvanometer oscillograph; eliminates



for **YOUR** *product*

WHICH PILOT LIGHT DO YOU NEED?

DIALCO



ACTUAL SIZE

Cat. #613529-211

THE BIG ONE

This Pilot Light Assembly was first made to accommodate the *S-11 lamp* and was intended for use in the cabs of great diesel locomotives.

This BIG one

or

this LITTLE one

Dialco HAS THE COMPLETE LINE OF INDICATOR and PANEL LIGHTS

THE LITTLE ONE

The miniaturization program on defense products required the development of this *sub-miniature* light. It is used on communication equipment and aircraft. Midget flanged base bulbs to fit are rated 1.3, 6, 12, and 28 volts.

ACTUAL SIZE

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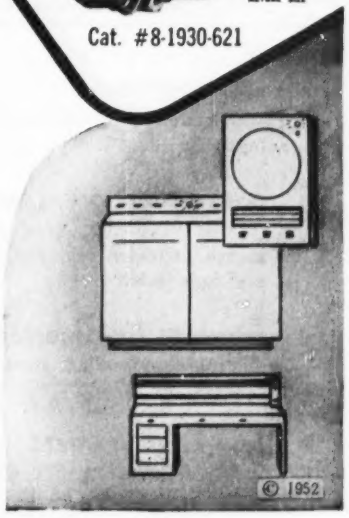
Samples to suit your own special conditions and requirements will be sent promptly and *without cost*. Just outline your needs. Let our engineering department assist in selecting the *right lamp* and the *best pilot light* for YOU.



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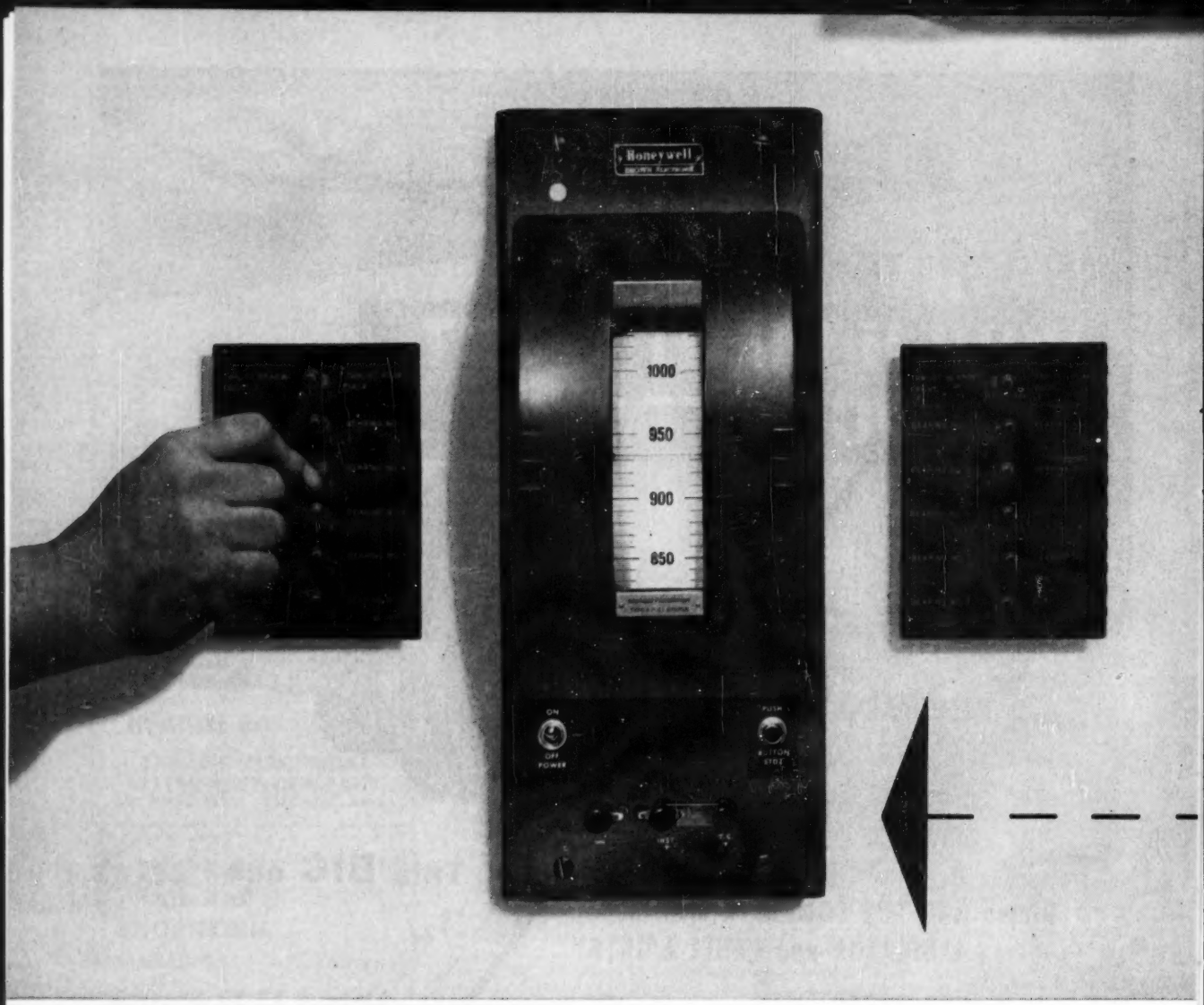
For more information circle **77** on inquiry card.



Look at these features!

compact case
approximately 6½ inches wide by 15⅜ inches high

easily-read drum scale
rotates vertically; graduated length 28⅝ inches provides big, legible scale divisions and numerals.

accurate hairline index
eliminates parallax errors, permits high readability.

fast measurement
full scale rotation in 4½ or 12 seconds for 60-cycle operation.

external key switches
can be located at the side of the indicator (as shown), below or above—wherever most convenient for the particular panel layout.

large number of points
additional key switch banks provide any desired number of temperature points. Legend plates facilitate identification.

high precision
calibrated accuracy is 0.2% of scale span.

variety of ranges
supplied for use with either thermocouples or resistance thermometers, in a selection of ranges applicable to power plant temperatures.

For more information circle **78** on inquiry card.

Squeezed for panel space?

THIS NEW

Honeywell temperature indicator

needs no elbow room!

CROWDED PANELS are no problem for this new temperature instrument . . . the Vertical Scale Precision Indicator. Its slender, compact case makes it a natural for graphic panels—and a readily-inserted, space-saving member of conventional generator and turbine boards.

Basically, it's the same *ElectroniK* Precision Indicator which the power industry and many others have used and relied upon for many years. But, its outside appearance has changed: it's a completely new design that places the bulk of the instrument mechanism *behind* the panel . . . uses the valuable front-of-panel space primarily for the indicating scale.

Equipped with key switch banks, the Vertical Scale Precision Indicator offers a fast, convenient way to spot-check temperatures in bearings, pumps, hydraulic couplings, motors and other potential hot spots.

Your local Honeywell engineering representative will be glad to discuss how this new instrument can save space on the new panels which you may be planning. Call him today . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4482 Wayne Ave., Philadelphia 44, Pa.

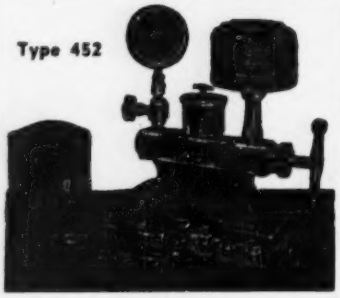
● **REFERENCE DATA: Write for new Bulletin No. 1541 on the Vertical Scale Precision Indicator.**

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

For more information circle **78** on inquiry card.

AMTHOR Dead Weight Pressure Gauge TESTER

Type 452



Modern design and construction puts this rugged precision instrument in a grade above the ordinary dead-weight testers.

Made in 14 ranges, to 10,000 lbs. maximum.

We guarantee 1/10 of 1 percent accuracy in each range.

The Type 452 is designed for simplicity and compactness. It incorporates the newest refinements and improvements. Adapters and tools are supplied, as well as either carrying case or protecting cover.

Immediate and intelligent attention will be given to your inquiries on all industrial speed measurement problems.

Drop us a line today.

Amthor Testing Instrument Co., Inc.
49a Van Sinderen Ave., Brooklyn, N.Y.

For more information circle **79** on inquiry card.

High Precision OPTICAL COMPONENTS Any Size For Astronomical and Physical Research

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Parabolic, Spherical, Ellipsoidal and Plane MIRRORS

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Complete Optical and Mechanical INSTRUMENTS

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For more information circle **80** on inquiry card.

NEW INSTRUMENTS

usual haywire rigs. It permits connecting signals through a "T" pad or directly to galvanometer while also providing space for plug-in series and shunt resistors. Plug-in resistor strip is located behind front panel, red sockets for series resistors and black sockets for shunt resistors. Unit illustrated accommodates fifty galvanometers. Units may be fabricated for any desired number of channels.—*Omni Engineering Corp., 2902 Porter St., NW, Washington 8, D. C.*

For more information circle **311** on inquiry card.

Crystal Detector

New "Model 148" crystal detector makes available sensitive readout from VHF-UHF directional couplers. Typical sensitivity when used with a 50-ua. 1140-ohm instrument is at least 30 ua. of rectified d-c. output for an rf. input of 140 mv. rms. New detector, for use with 50-ohm transmission lines operating at frequencies from 30 to 1,500 Mc., includes a 1N21B crystal and a built-in low pass output filter.—*Sierra Electronic Corp., 1050 Brittan Ave., San Carlos 2, Calif.*

For more information circle **312** on inquiry card.

ELECTRICAL AND ELECTRONIC COMPONENTS

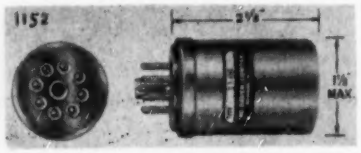
Junction Transistors

New series of junction transistors come in cases which have undergone a 40 percent size reduction: over-all length reduced from 0.500 in. to 0.300 in. Connections are made to case through three 1.5-in. tinned leads suitable for soldering into circuit or clipping to desired length and plugging into subminiature socket. Moisture-proof glass-to-metal hermetic sealing and electrically insulating finish remain unchanged. Alpha (current amplification factor) is a guaranteed minimum of 0.90 in "Type 200," 0.95 in "Type 201," and 0.98 in "Type 202."—*Texas Instruments Inc., 6000 Lemmon Ave., Dallas 9, Texas.*

For more information circle **313** on inquiry card.

Sealed Resistor Networks

New "Type 1169" hermetically-sealed resistor network, designed to be plugged into standard octal sockets, is available in completely matched sets of resistors (up to five 1-meg or

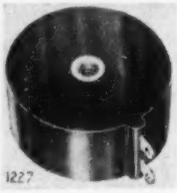


ten half-meg) interconnected as desired. Units resist the most severe military shock and vibration tests, salt water immersion test, and temperature cycling from –65 C. to 125 C. —*The Daven Company, 191 Central Ave., Newark 4, N. J.*

For more information circle **314** on inquiry card.

Plastic Toroids

New toroids are molded in plastic, eliminating mounting problems and fragility. Two types of brass bushings in center are available; one threaded for a 6/32 screw, the other provides a hole to clear 6/32, keeps mounting pressure off plastic and permits cleaner mountings. Maker's "Types 206, 848, 930, 671, 395 and 269" are available in this new form.—*Communication Accessories Co., Hickman Mills, Mo.*



For more information circle **315** on inquiry card.

Subminiature Transformers

New subminiaturized supply transformers, said to have extremely high performance characteristics in relation to their size and weight, are produced on special order to individual specifications. They withstand severe shock, temperature ranges and vibration. "Model DR-T 107" (illustrated), developed primarily for printed-circuit applications, delivers up to 5 watts at 400 cps. and is designed to feed a pair of synchro control transformers. —*D & R Ltd., Santa Barbara, Calif.*

For more information circle **316** on inquiry card.

External-phasing VDRs

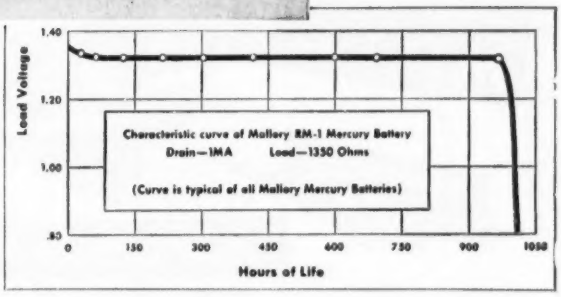
New "Series C-200 External Phasing Potentiometers" feature non-linear functions, larger tap ring, adjustable taps, and full 360-deg. external phasing. Custom logarithmic, sine-cosine and other shaped function units for computer, servomechanism, and guided missile control problems can be supplied. Up to eight taps can be mounted on one unit. Taps may be moved, or additional taps added later. Owing to unitized design, self-contained 2-in. unit is said to be "ideal for ganging" without special shafts. After installation, individual units in a multiple section may be rotated independently of one another by loosening clamp-ring set-screw.—*De-Jur Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.*

For more information circle **317** on inquiry card.

Vacuum Voltage Divider

New capacitance type vacuum voltage divider features a fully-shielded low-voltage probe and a purely capacitive circuit loading as low as 1.5

For Constant Voltages... Use Mallory Mercury Batteries



The constant discharge voltages shown in the curves are characteristic of the uniform, dependable power delivered by Mallory Mercury Batteries. This is especially important in mobile communications equipment, hearing aids, delicate optical equipment and many kinds of instruments in which constant discharge voltages are imperative for best performance.

This is only one advantage of Mallory Mercury Batteries, however. They operate dependably at microamperes or drains of 50 amperes . . . intermittently or continuously . . . always providing a dependable, uniform source of power —even after long periods of storage.

If these characteristics will improve the operation of your equipment, then let us send you complete information. Multi-cell battery stacks and packs can be designed to fit your exact needs.

Use Mallory Mercury Batteries for applications where:

- Constant voltage or current is required
- Size and weight are important
- Long storage periods are involved
- Battery leakage cannot be tolerated
- Wide temperature and pressure ranges are encountered
- Severe impact and shock is expected

For Transistor Applications

Mallory Mercury Batteries are especially suited for transistor applications . . . where constant voltage and constant current are required.

P. R. MALLORY & CO. Inc.
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SERVING INDUSTRY WITH THESE PRODUCTS:
Electromechanical—Resistors • Switches • Television Tuners • Vibrators
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P. R. MALLORY & CO. INC., BATTERY DIVISION, NORTH TARRYTOWN, N.Y.

For more information circle **81** on inquiry card.

PREVENT

HEART DISEASE

IN YOUR SYNCHRONOUS POWER APPLICATIONS

USE THE *New!* HAGEN SYNCHRONOUS MOTOR

OUTSTANDING FEATURES

New! IMPROVED MODEL 50

1. 40 oz. in. torque at 1 RPM
2. Coils for 24, 110, 220, 440, and 550 volts (Without resistors or transformers)
3. Frequencies—60, 50 and 25 cycle
4. Wide selection of output speeds from 1800 to 1/6 RPM
5. For ambient temperatures − 20°F. to + 120°F.
6. Sealed lubrication.
7. Mount in any position
8. Uses accurate machine cut gears
9. Power input
   Model 50 — 7 watts
   Model 52 — 10 watts
   Model 56 — 10 watts
10. Ground and polished steel shafts.

Write for

NEW BULLETIN 1053

The Hagen Motor is designed for industrial use where a synchronous motor heavier than the clock-type is required.

Extensive research has developed the Model 50 motor which incorporates many new features to . . . SOLVE your motor problems.

HAGEN MANUFACTURING COMPANY, INC.
MOLINE, ILLINOIS

Subsidiary of EAGLE SIGNAL CORPORATION

For more information circle **82** on inquiry card.

mmfd.; can be used with an oscilloscope or voltmeter to measure both low-frequency and rf. voltages up to 60,000 volts; also to measure double voltages in a balanced-to-ground arrangement. Voltage division ratios as high as 10,000:1 and as low as 8:1 can be attained with simple capacitive shunts across voltmeter or 'scope.—*Jennings Radio Mfg. Corp., P. O. Box 1278, San Jose, Calif.*

For more information circle **318** on inquiry card.

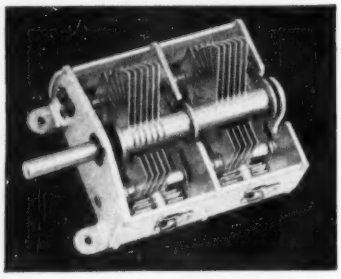
Subminiature Capacitor

New "Silverlytic" subminiature electrolytic capacitor, for transistor applications requiring high capacitance in a small container at low voltage, is available in ratings of 0.1, 0.2, 0.3, 0.5 and 1.0 uf. at 10 v.dc., 2.0 uf. at 5 v.dc., and 4.0 uf. at 4 v.dc. Operating temperature range −30 C to 65 C. Maximum leakage current 2 ua. after 5-min. application of rated voltage.—*P. R. Mallory & Co., Inc., Capacitor Div., 3029 E. Washington St., Indianapolis 6, Ind.*

For more information circle **319** on inquiry card.

Variable Air Capacitors

New variable air capacitors for all UHF and RF applications are of instrument quality: three-point mounting; hardened stainless steel ball bearings; all rotors and stators soldered; hardened silver-plated beryllium-copper wipers to avoid any electrical noise; compression-loaded ceramic rod stator suspension to give unit an exceptionally long dielectric path and mechanical reliability; variable air trimmer integral part of each section. Single to four-gang sections are standard.—*Johanson Mfg. Corp., Boonton, N. J.*



For more information circle **320** on inquiry card.

Tapped Delay Lines

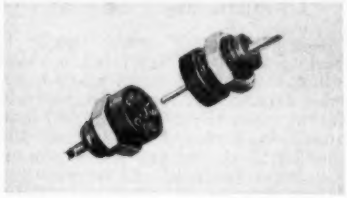
New tapped wide-band delay lines with exceptional transient response feature light weight, small size, and hermetically-sealed construction. A unit of tapped delay line consists of ten section of m-derived networks. A capacitor with one-half normal shunt-

ed capacitance, connected at each end of m-derived network, is easily removable to permit adjustment to compensate for effects of external circuit components. Each section is designed to give linear phase shift beyond 70 percent of cut-off frequency, and to give a frequency response curve approaching Gaussian in shape. Thus, it is said, both risetime and overshoot are much smaller than those of any other delay lines with equal time delay. Six types are available, with total delay times from 0.1 to 5 usec.; from 0.01 to 0.5 usec. delay between taps; from 75 to 1000 ohms impedance; from 32 to 0.6 Mc. cutoff frequency; and from 0.01 to 0.5 usec. maximum risetime.—*Advance Electronics Co., P. O. Box* 394, *Passaic, N. J.*

For more information circle **321** on inquiry card.

Single-pin Connector

New "Series FHL" (shown in actual size) is a single-pin miniaturized connector providing an easy means for passing a single lead through a



rack and panel arrangement; also suitable for use as a feed-through disconnect. Socket contacts and pins are gold-plated over silver. Choice of three molding compounds: mineral-filled Melamine, Plaskon-reinforced alkyd type, and diallyl phthalate.—*DeJur-Amsco Corp.*, 45-01 *Northern Blvd., Long Island City* 1, *N. Y.*

For more information circle **322** on inquiry card.

Film-type Resistors

New "Type MBC" is a molded boron carbon unit rated at 0.5 watt, said to feature greatly improved moisture, load life, and shelf life characteristics over unmolded types. Size is equivalent to that of a 1-watt composition resistor: body length 0.562 ± 0.062 in. New "MBC" surpasses characteristics outlined in MIL-R-10509A.—*International Resistance Co.*, 401 *North Broad St., Philadelphia* 8, *Pa.*

For more information circle **323** on inquiry card.

Deposited-carbon Resistors

New "Industrial Line" of deposited carbon resistors for industrial and instrument applications supplements "MIL-line" series designed for military applications. New line is said to have stability and long service life. It includes three sizes of ½-watt rating as well as a 1-watt and a 2-watt unit.—*The Radell Corp.*, 7900 *Pendleton Pike, Indianapolis* 26, *Ind.*

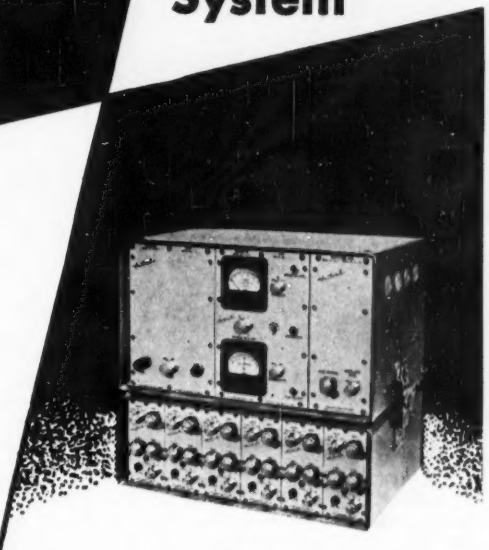
For more information circle **324** on inquiry card.

Pulse Transformer Kit

New plug-in type transformer kit permits a circuit designer to wire a 7-pin miniature tube socket into his circuit in place of pulse transformer

Heiland Amplifier System

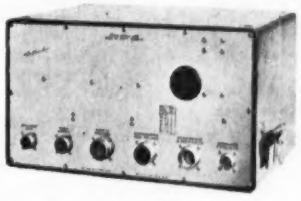
The most complete, yet easiest to operate amplifier system ever developed for oscillographic recording



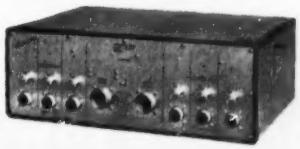
Model 119 Carrier and Linear or Integrating Amplifier System.

Heiland's model 119 Amplifier System, used in conjunction with Heiland Recording Oscillographs, has received wide acclaim from engineers for its extreme versatility, accuracy and simplicity of operation in the amplification of static and dynamic current phenomena.

This small, compact instrument, which can be provided for either rack, table, or shock mounting with available accessories, is housed in a rugged, yet lightweight cast aluminum case finished in attractive silver-gray gloss enamel. For complete specifications write or wire for our Bulletin 107.



Power Supply Assembly (Rear View)



Amplifier Assembly (Rear View)

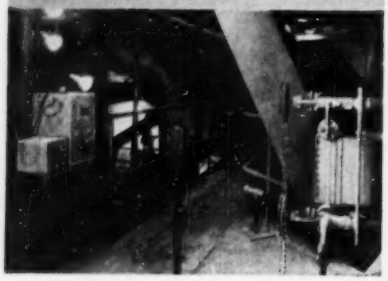
Complete information on other Heiland products will be supplied on request.

Heiland Research Corporation 130 East Fifth Ave., Denver, Colorado

For more information circle **83** on inquiry card.

NOW You Can *See* Where You Can't *Look*

5 YEARS of CONTINUOUS OPERATION PROVE Dependability OF DIAMOND "UTILISCOPE"
(WIRED TELEVISION)



"UTILISCOPE" camera at drum elevation SEES actual boiler water level.

In 1948, Tidd Plant of Ohio Power Company (subsidiary of The American Gas & Electric Company) installed a Diamond "Utiliscope" so that the operator at the control panel could SEE the boiler water gauge several floors above. The camera location (adjacent to the big boiler drum) is hot and dusty. Auxiliary machinery causes vibration. The installation (including the original camera tube) has been in continuous use . . . 24 hours a day . . . 7 days a week for over 5 years, with very little maintenance. This is the first system of industrial television purchased in the U.S. and is still in continuous operation.

Probably there are places in your plant where you can use the DEPENDABLE "Utiliscope" (wired television) . . . the great new industrial aid. It is saving money and improving operations in steel mills, power plants, foundries, coal mines, and a wide variety of manufacturing plants. Use the coupon below.

"Utiliscope" Receiver

"Utiliscope" Camera

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DIAMOND POWER SPECIALTY CORP.
LANCASTER, OHIO

Please send me without obligation a copy of new Bulletin No. 1136 showing how the Diamond "Utiliscope" (Wired Television) is being used to cut costs, improve operations and promote safety.

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DIAMOND POWER SPECIALTY CORP.
FIRST IN INDUSTRIAL TELEVISION
LANCASTER, OHIO
OFFICES IN 39 PRINCIPAL CITIES
Diamond Specialty Limited—Windsor, Ontario
SINCE 1903, DIAMOND HAS MANUFACTURED QUALITY EQUIPMENT FOR INDUSTRY

For more information circle **84** on inquiry card.

NEW INSTRUMENTS

and later to plug in a variety of pulse transformers until required circuit performance is obtained. New kit contains a selection of 12 standard plug-in type pulse transformers, all having different impedances or turns ratios, all designed to pass MIL-T-27 specs.—*Polyphase Instrument Co., Bryn Mawr, Pa.*

For more information circle **325** on inquiry card.

Mercury Batteries

New line of transistor power supplies and "A" battery designs with a new top contact construction provide added protection against leakage and corrosion, in addition to high ratio of electric energy to size and weight. New double top construction and improved methods of cell sealing effectively prevent electrolyte seepage from within cell. Venting system structure allows greater expansion within cell to keep gas pressure at a safe level and effectively vent any excessive gas pressures which may build up as a result of short circuits or other abnormal conditions. New transistor power supplies incorporate positive intercell connections and new contact features for improved hearing aid operation; maintain substantially constant voltage and energy output level over wide temperature and operating variations.—*Battery Div., P. R. Mallory & Co., Inc., North Tarrytown, N. Y.*

For more information circle **326** on inquiry card.

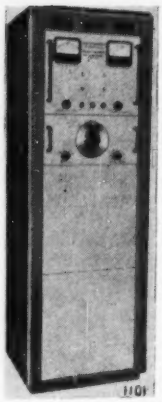
POWER SUPPLIES

Tubeless 28-v.dc. Supply

New "Nobatron Model MA2850" is a non-electronic regulated d-c. supply. Using magnetic amplifier principles, it delivers 50 amps. at 28 volts (adjustable between 23 and 32 volts). Regulation accuracy is 1 percent against line and load combined. New unit was originally designed for testing aircraft heaters, pitch changers, inverters, radar installations, fire control systems, etc. However, it is said that its high capacity, accuracy, and trouble-free dependability of tubeless construction indicate many uses in and out of aircraft field.—*Sorensen & Co., Inc.*, 375 *Fairfield Ave., Stamford, Conn.*

For more information circle **327** on inquiry card.

Variable-frequency Power Generator



New "Model 1000A" comprises an audio oscillator (said to be "the finest") driving a linear high-power amplifier followed by stabilizing and voltage-control networks. It will deliver 500 va. continuous duty over spectrum of 30-6000 cps. and regulate voltage over entire 0-250-volt range. Applications include vibration shake-table excitation; servo analysis; testing cables, transformers, etc.—*Industronics, Box* 424, *Arlington Heights, Ill.*

For more information circle **328** on inquiry card.

15-amp. D-c. Supply

New "MR532-15" power supply is magnetic-amplifier-regulated, is rated at 5-32 v.dc. at 15 amps.; has a regulation accuracy of 1 percent (a) from 5 to 32 v.dc., (b) from 1/10 full load to full load, (c) from 105 to 125 v.ac. Its ripple voltage is 1% rms at 32 volts at full load and its recovery time is 0.1 second. Unit has 4½-in. ammeter and 4½-in. voltmeter, bench-type cabinet can also be used for 19-in. rack mounting. Among features: no electronic components; output continuously variable; magnetic type circuit-breaker on the d-c. side with time delay provision for starting motors.—*Perkin Engineering Corp.*, 345 *Kansas Street, El Segundo, Calif.*

For more information circle **329** on inquiry card.

Constant-voltage Supply

New "Constant Reference Voltage Supply" converts a-c. into a d-c. voltage that will remain constant within 0.12 percent. Though designed primarily for variable-speed motor drives and d-c. servo systems, it is said to be suitable to replace standard cells. When connected to a 115-volt supply (50 to 400 cps.), unit will supply a reference potential adjustable from 0 to approx. 87 volts, maintained to 0.12 percent with any load not exceeding 1 ma. and throughout a temperature range of –50 C. to 40 C. with line voltage changes from 90 to 135 volts. Physically, it is a plug-in unit for standard 8-pin octal socket. Immediate delivery.—*Servo-Tek Products Co., Inc.*, 1086 *Goffle Rd., Hawthorne, N. J.*

For more information circle **330** on inquiry card.

HF HV Power Supply

New "HV-2500 High Voltage Power Supply" high-frequency klystron supply provides two channels: high and low voltage, with filament supplies for each. Two time delays are incorporated for channel No. 1: first time delay allows all heaters to attain their proper operating temperatures before high voltage is applied. When high voltage is applied, only cathode,

ASCO® BIG VALVE Values
designed into SMALL Solenoid Valves

2-Way and 3-Way General Purpose Valves in the ⅛" to ½" Pipe Size Range

Design Features

* Capable of sustained fast repetitive operations over very long periods
* Snap action — opening and closing
* Full size orifices, assuring maximum unrestricted flow
* No closely fitted parts to make valve susceptible to jamming by small foreign particles
* Compactness — sizes to meet any restrictive space requirements

These small ASCO Solenoid Valves — examples of our design skills — may be just what you need for controlling automatically the flow of liquid or gas in your machine, instrument or pipe line. Complete details will be sent on request. If you have other control problems, why not let our engineers work on them? We have been serving industry in the field of electromagnetic controls for 65 years and can offer a great variety of Solenoid Valves covering many different services.

ASCO®

General Purpose Packless Solenoid Valves for

Air, Gas, Water, Refrigerants, Light Oils, Heavy Oils and Other Non-Corrosive Fluids. 212°F. Maximum Temperature for Liquids and Gases; up to 450°F. for Steam (High Temperature Coils).

1. Bulletin 8262
   ASCO 2-Way Valve
   Pipe Size — ⅛" and ¼"
   Maximum Pressure 1000 psi
2. Bulletin 8265
   ASCO 2-Way Valve
   Pipe Size — ⅜"
   Maximum Pressure 250 psi
   (Steam to 175 psi)
3. Bulletin 8268
   ASCO 2-Way Valve
   Pipe Sizes — ¾" and ½"
   Maximum Pressure 475 psi
4. Bulletin 8314
   ASCO 3-Way Valve
   Pipe Size — ⅛"
   Maximum Pressure 125 psi
   (Other Small 3-Way ASCO Valves to ½" pipe size available)

ASCO Solenoid VALVES

Write for free pamphlet "Small Solenoid Valves"

Automatic Switch Co.

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For more information circle **85** on inquiry card.

How to keep air-operated instruments healthy

When air-operated instruments breathe dirty air, they soon get clogged up, lose their accuracy and eventually wind up in the repair shop.

● But moisture, dirt or oil can't harm your instruments if you install a Cuno MICRO-KLEAN filter in your air line.

MICRO-KLEAN's double-capacity cartridge positively removes *all* entrained moisture together with foreign particles down to one micron in size.

One of the most attractive things about MICRO-KLEAN is its price. You can get this modern micronic filter (Model 1C1G) for only $5.45—a very small "premium" to insure your instrument investment. This model has ⅜" inlet and outlet pipe size, 125 PSI maximum operating pressure and flow capacity of 15 CFM (free air).

It'll pay you to clip the coupon and send it off today.

Cuno Engineering Corporation
Dept. 3817M South Vine Street, Meriden, Connecticut

☐ Please send me a Cuno MICRO-KLEAN Model 1C1G filter for air-operated instrument protection. Bill me $5.45.

☐ I'd like some more information about MICRO-KLEAN. Send me your free MICRO-KLEAN Air Line Filter Bulletin.

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CUNO ENGINEERED FILTRATION

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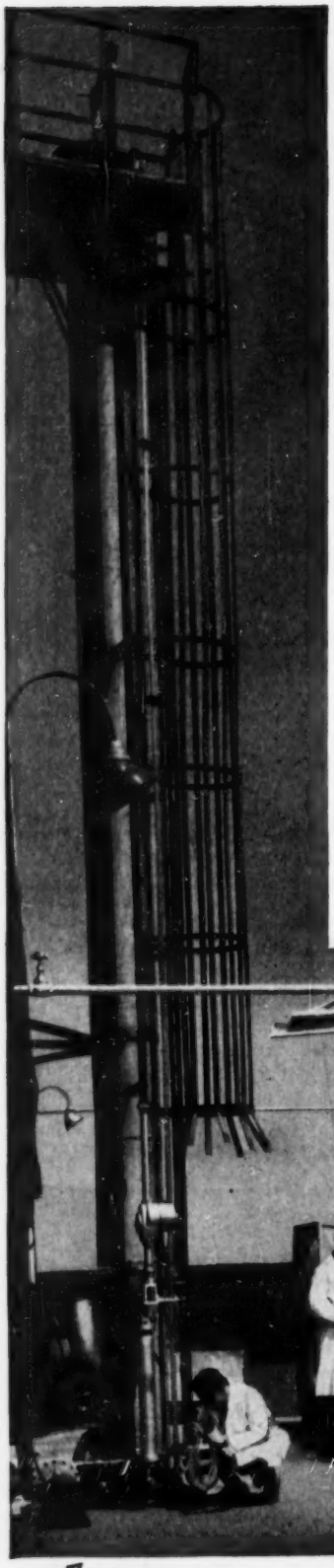
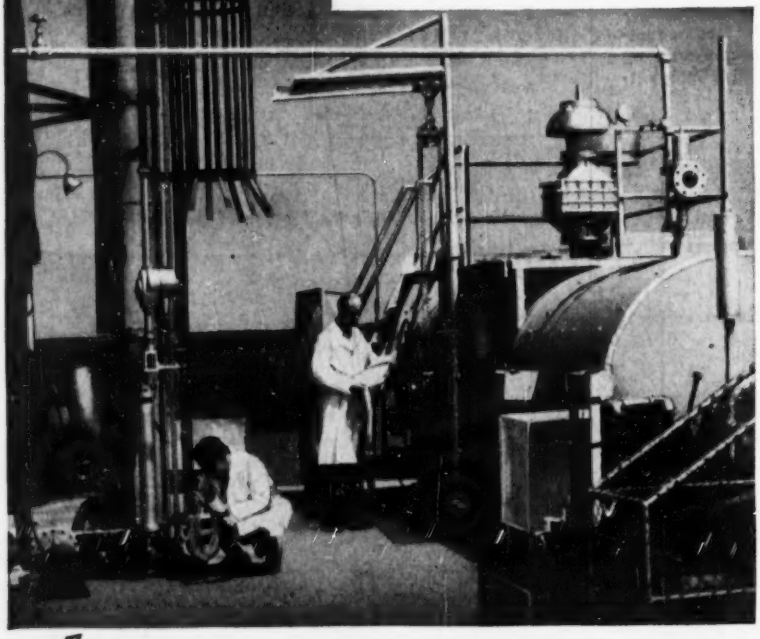


"Varec" meets the Challenge of Obsolescence!

The PETRO-CHEMICAL INDUSTRY is a dynamic one—continuously changing and constantly expanding to boost output and produce better products. This creates a high rate of obsolescence that demands new equipment designs and new material applications for replacements.

Vapor Recovery Systems Company is timing its production to meet this demand. Our Engineering department is continually testing new and better designs, seeking the finer quality parts, and adopting the most corrosive-resistant materials available to contribute to the progress of industry.

Whether you are installing or improving your TANK EQUIPMENT—GAS CONTROL DEVICES—GAUGING SYSTEMS, you'll find the "VAREC" line prepared to do the job in a better way.



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THE VAPOR RECOVERY SYSTEMS COMPANY
2820 NORTH ALAMEDA STREET • COMPTON, CALIFORNIA
Manufacturers of "VAREC" Equipment
Representatives in Principal Cities of the World

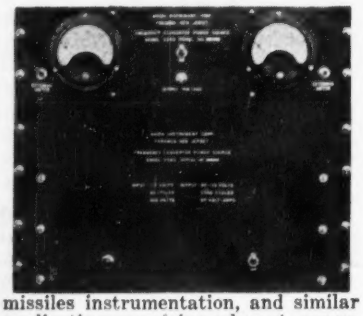
For more information circle **87** on inquiry card.

reflector, and focus potentials are applied, all above ground. After second time delay, positive end of power supply is grounded, thus connecting anode of klystron to power supply. Should line power fail, even for an instant, high voltage is removed, and entire cycle is repeated. A voltmeter and milliameter are provided. A four-position switch allows selecting either one of four potentials: reflector, focus, resonator or low voltage.—*Radar-Electronics, Inc., 229 West 28th St., New York 1, N. Y.*

For more information circle **331** on inquiry card.

Frequency Converter

New "Model 2500 Frequency Converter" delivers 60 va. of regulated 2500-cps. power; is said to be "ideally suited for work on computers, guided



missiles instrumentation, and similar applications requiring adequate power coupled with precision voltage and frequency regulation." Frequency is controlled by a tuning fork. Protection against frequency change due to component failure is assured by output cutoff relay. Monitored output is adjustable between 90 and 115 volts.—*Avion Instrument Corp., Div. Am. Car & Foundry Co., 299-50 State Highway No. 17, Paramus, N. J.*

For more information circle **332** on inquiry card.

Reference Power Supply

New "Model MM-6 Ref-Pak Reference Power Source" is a precisely regulated (0.5 percent) 30-v.dc. supply, potted in a 2.5x2.5x2.5-in. can. Units are available in ratings from 0.1 ma. to 50 ma. d.c.; are said to make "ideal" sources of bias for transistors, magnetic amplifiers, voltage regulators, etc., as well as reference sources for automatic control systems; can be used to replace VR tubes, constant-voltage transformers, etc.—*Magnetic Controls, Inc., 119 W. 63rd St., New York 23, N. Y.*

For more information circle **333** on inquiry card.

Transformer-rectifiers

New line of regulated transformer-rectifiers offers a light-weight means for obtaining spot current required for d-c. equipment on aircraft; eliminates heavy d-c. bus bars which otherwise would be needed. Voltage regulation is held to within plus or minus 0.7 v.dc. in all units. Ripple is 4.5 percent, efficiency 77 percent minimum, and power factor approx. 75 percent. Units with ratings of 50,

100, and 200 amps. d.c. at 28 volts are available. Equipment comprises selenium cells, transformer, saturable-reactor regulating network, cooling fan, and aluminum casing.—*General Electric Co., Schenectady 5, N. Y.*

For more information circle **334** on inquiry card.

ELECTROMECHANICAL COMPONENTS

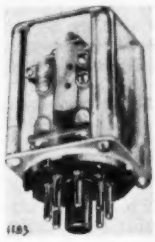
Time Delay Relay

New "Type SF" of maker's "Agastat" time delay relay is solenoid-operated, pneumatically-controlled; and time delay is adjustable from outside housing from approx. 30 milliseconds to more than 1 min. Enclosure is completely sealed and filled with inert gas under pressure. Currently manufactured for 24-28 v.dc., it will be available for other standard voltages, a.c. and d.c. Double-break contacts in s-p., 2-p., and 3-p. models.—*AGA Div., Elastic Stop Nut Corp.*, 1027 *Newark Ave., Elizabeth, N. J.*

For more information circle **335** on inquiry card.

Plug-in Plate-circuit Relay

New "KCP" plate-circuit current-actuated plug-in relay enclosed in a clear polystyrene dust cover is intended for use in original equipment using photocell control or similar electronically - operated circuitry. Contact rating is 2 amp. 115-v.ac. non-inductive load. Operating coil power is 125 milliwatts per movable pole with a contact pressure of approx. 10 grams. Nine models available, with various contact combinations, various coils and various pull-in values.—*Potter & Brumfield, Princeton, Indiana.*



For more information circle **336** on inquiry card.

Resonant-reed Relay

New "Frahm Reed Relay" responds to an alternating signal having frequency and amplitude values that lie within specified bands. Transmission of an number of control signals over a single circuit (wire or radio) is said to be simplified with reed relays. In a typical application, a control function is used to turn off or on a series of low-frequency signals (50-500 cps.). Signal is transmitted to remote location where it operates reed relay. Since each relay will only respond to a narrow frequency band, a number of

WINSLOW MEGOHM DECADE RESISTANCE BOXES

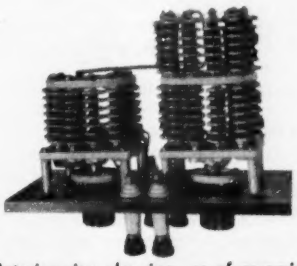
Accuracy within ±0.1% in high megohm ranges!

Model 341, 4 dials, measures to 111.1 megohms in steps of 10,000 ohms. Fully shielded heavy aluminum case. Ground post for convenient AC measurements

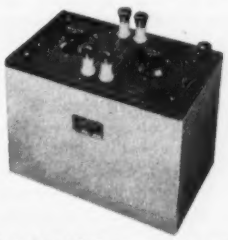
Resistance elements in these Megohm Decade Boxes are wound non-inductively on ceramic forms with a specially developed alloy wire having a negligible temperature coefficient over a range from —50° C to +80° C. Each spool's resistance, as well as that of the entire decade, is held within a deviation of 1/10 of 1% throughout this temperature range, and provides even greater stability at room temperatures. Accuracy is maintained over a frequency range from DC to 20 KC.

Each spool safely dissipates 2 watts. The switch arm consists of multiple leaves of phosphor bronze that are self cleaning by wiping action, and the entire switch is heavily silver plated. This construction thereby assures continued accuracy of measurements over long periods of constant use.

Winslow Megohm Decade Boxes are available in 1, 2 and 4 dial models covering resistance ranges to 111.1 megohms. *Write for catalog.*



Interior view showing use of ceramic insulation throughout. This construction insures minimum current leakage and highest accuracy.



Model 340, 2 dials, measures to 110 megohms in steps of 1 megohm. Heavy aluminum case and panel provide complete shielding for AC measurements. Ground post in panel. Can also be used as a potential divider.

THE WINSLOW COMPANY

NINE LIBERTY STREET • NEWARK 5, NEW JERSEY

For more information circle **88** on inquiry card.

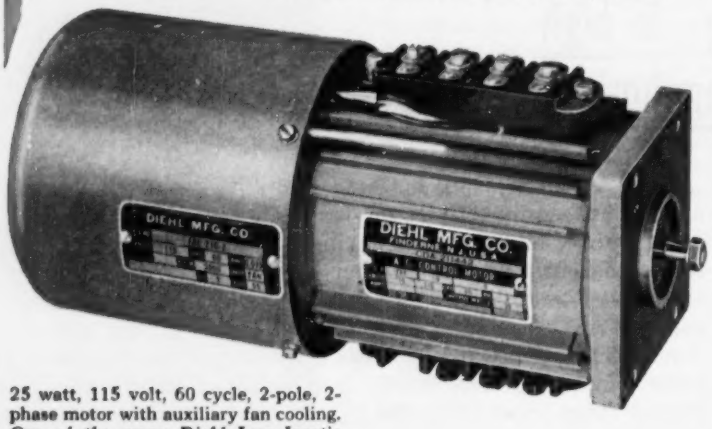
Design in Confidence

with

DIEHL

LOW INERTIA A.C. SERVO MOTORS...

. . . for Feedback Control Systems



25 watt, 115 volt, 60 cycle, 2-pole, 2-phase motor with auxiliary fan cooling. *One of the many Diehl Low Inertia A.C. Servo Motors available.*

CONSIDER THESE FEATURES

• High starting torque • Low rotor moment of inertia • Widest selection of ratings • Samples of many sizes available from stock • Engineering assistance offered when desired • Production quantities available in a reasonable time — at a reasonable price.

Diehl *originated* the Low Inertia A.C. Squirrel Cage Induction Motor — and Diehl's leadership in the field is still being maintained!

Originally designed for high-performance military servo systems, these motors are now being extensively used in the armed services with various types of electronic equipment. In industry, too, Diehl Servo Motors and components are being successfully applied in the design of automatic controls and a wide variety of other applications where optimum performance at reasonable cost is essential.

Meeting all appropriate JAN specifications, the two-phase servo motors can be supplied in sizes ranging from 2 watts to 750 watts mechanical output, 60 or 400 cycle supply. The smaller sizes include units with integrally-mounted tachometer generators for feedback. Many of the ratings are available with the control winding impedance specially designed for operation directly from the plates of electron tubes. Samples of most 60 cycle, and some 400 cycle, units are available for immediate shipment.

Our engineering staff will gladly help you select the motors best suited to your specific requirements. A request on your letterhead will bring you a copy of Technical Manual No. IN0154 describing Diehl Servo Motors and related equipment.

Other Available Components:

D.C. SERVO SETS • RESOLVERS

MINIATURE PERMANENT MAGNET D.C. MOTORS

Diehl

DIEHL MANUFACTURING COMPANY

Electrical Division of THE SINGER MANUFACTURING CO.

Finderne Plant, SOMERVILLE, N. J.

Atlanta Baltimore Boston Chicago Detroit New York Philadelphia Worcester

For more information circle **89** on inquiry card.

NEW INSTRUMENTS

relays can be operated simultaneously by making use of an equal number of source generators with non-overlapping operating frequency bands. In 200-500-cps. range it is possible to operate up to 16 channels; where four relays are used, 1820 control functions can be handled.—*James G. Biddle Co.*, 1316 *Arch St., Philadelphia* 7, *Pa.*

For more information circle **337** on inquiry card.

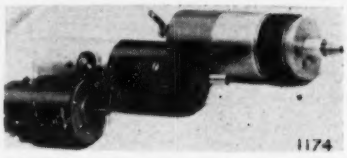
Office-machine Motor

New "Type K-4" induction motor, specifically designed for office machines, features height and width of 2-⅞in., constant speed, extremely quiet operation, no radio interference, light weight and five mounting arrangements.—*Bodine Electric Co.*, 2254 *W. Ohio St., Chicago* 12, *Ill.*

For more information circle **338** on inquiry card.

Instrumentation Motors

New miniature permanent-magnet d-c. motors and gear motors (illustrated) can be supplied with overload torque limiting clutches. Those shown

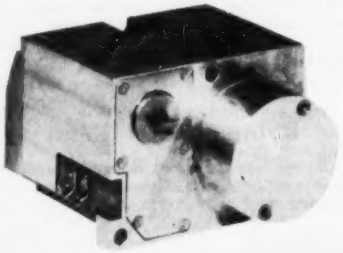


measure 1.187 in. in diameter. Not illustrated: two new 400-cps. gearmotors, one 3 in. long x 1.5 in. diam., 80-in.-oz. output torque; the other 2 in. long x 1 in. diam., 10 in.-oz. All have output speed variable as low as 1 rpm.—*Mission-Western Engineers, Inc.*, 132 *West Colorado Blvd., Pasadena* 1, *Calif.*

For more information circle **339** on inquiry card.

Power Unit

New "PMGG-X11-C" motor package consists of a PMM motor, adjustable governor, adjustable gear train, adjustable slip clutch designed to

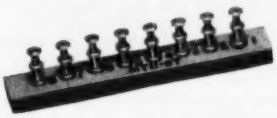


take care of required torques, also *R-C* filter circuit for protection of governor contacts. Motor is available for 12 and 24-v.dc. and for 115-v.dc. on special order. Governor maintains constant speed of output shaft: guaranteed to 0.5 percent over a change of ± 10 percent in voltage. Geartrain for output speeds from 0.5 rpm. to 20,000 rpm. and torques from 10 to 100 in-oz.—*Pacific Instruments & Controls Co.*, 3593 *Hayden Ave., Culver City, Calif.*

For more information circle **340** on inquiry card.

Miniature Terminal Boards

New "Series MT Continental" miniature terminal board (illustrated in actual size) has eight turret type terminals, tinned for easy soldering,



molded directly into body. Boards can be molded in mineral filled Melamine, Plaskon-reinforced alkyd type, and diallyl phthalate.—*DeJur-Amsco Corp.*, 45-01 *Northern Blvd., Long Island City* 1, *N. Y.*

For more information circle **341** on inquiry card.

Laboratory Relay

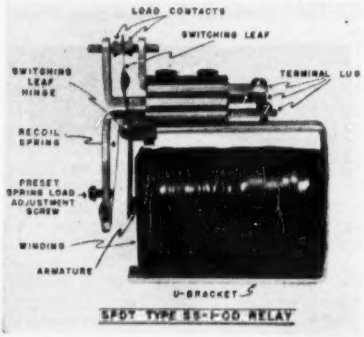
New model of maker's "Laboratory Relay" has been completely redesigned. Contacts of regulating devices used in conjunction with it are pro-

tected from progressive deterioration; and mercurial regulators may be used without loss in sensitivity consequent to mercury contamination. A time delay of one to two seconds minimizes chatter without causing loss of sensitivity. Electric circuit is isolated from line; a grounding lead eliminates possibility of shock to operator and possibility of erratic operation Two 115-v.ac. outlets: one energized when regulator closes, the other operating inversely; each capable of supplying 10 amps.—*E. H. Sargent & Co.*, 4647 *W. Foster Ave., Chicago* 30, *Ill.*

For more information circle **342** on inquiry card.

Supersensitive Relay

New "Style SS- 1-O.D." is said to have a wider range than any like relay in its price field; engagement-demand can be continuously adjusted from as little as 0.25 milliwatt to 5 milliwatts and higher. Relay has withstood a 500-*G* shock while operating



SPDT TYPE SS-FOD RELAY

Circle **90** on inquiry card. ⟶

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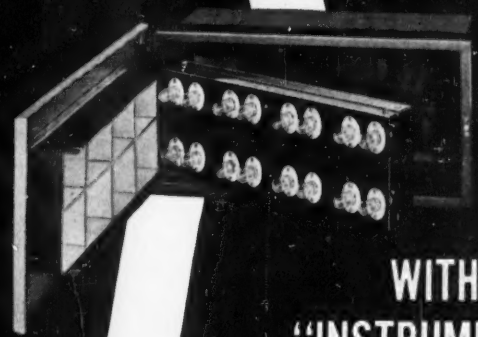

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LOOK inside the new Universal PANALARM "50". You will realize that here, at last, is an annunciator system built for *long term* dependability and service. Built to match the responsibility an annunciator must assume in your plant.

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All moving parts and contacts of the PANALARM "50" are within hermetically sealed, plug-in units. They are corrosion-proof and suitable for Class I, Div. 2 locations. All connections are made to a single terminal block . . . with ample space for wiring.

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Standard equipment includes electric temperature and humidity recording controllers, altitude gauge, mercury manometer, 8-post terminal panel, and pre-set control for maintenance of altitude. Special features may include high-voltage lead-ins, side viewing windows, hand-operated tuning shafts, high wattage dissipation, utility ports up to 6" diameter. Also stainless steel power shafts, special instrumentation, rapid cooling and heating rates, low temperatures to −150°F., altitudes to 120,000 ft. Also custom-size chambers.

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For more information circle **91** on inquiry card.

NEW INSTRUMENTS

at its minimum engagement demand. Available in s-p.s-t. and s-p.d-t. switching action. Essentially a d-c. relay, new unit is also furnished with built-in selenium rectifiers for a-c. duty; can also be supplied hermetically-sealed. Both load contacts are fine-thread screws that can be independently positioned in contact-leaves. By positioning them so that gap between magnet-attracted end of switching leaf and magnet core is only slightly altered by leaf's travel, relay's drop-out level can be held to 90 percent of its engagement demand. Conversely, drop-out level can be held to as little as 20 percent of engagement demand. In all positions of switching leaf, engagement-demand is fixed by recoil springs pre-loading.—*Techniflex Corp., Port Jervis, N. Y.*

For more information circle **343** on inquiry card.

Rotary Switch

New "Type 87-EM" 8-amp. rotary switch has eight poles on one deck, a feature made possible by "knee-action" rotor which is said to give uniform contact pressure and low contact resistance throughout life of switch. New unit measures 2.75 in. diam. x 1.94 deep; is available in multiple deck arrangements. One to five positions per pole available with shorting-type action; up to three positions per pole with non-shorting action.—*The Daven Co.* 191 *Central Ave., Newark, N. J.*

For more information circle **344** on inquiry card.

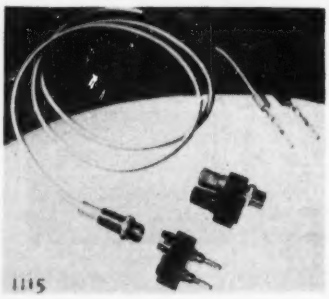
Foot Switch

New "Executive" footswitch incorporates two switches in one with selective circuits and guaranteed mechanical interlock. Pivoting from center, only one circuit can be operated at a time. Either switch, or both, may be wired as N-O or N-C; s-p.d-t.—*Linemaster Switch Corp.*, 428 *Woodstock Terrace, Woodstock, Conn.*

For more information circle **345** on inquiry card.

Conversion Plugs and Shielded Lead

New "CP-122 Conversion Plugs" (amphenol to spaced jacks) and "CP-221" (spaced plugs to amphenol) simplify interconnections between measuring instruments and other equipment having ¾-in.-spaced banana plugs, or corresponding jack type terminals, with other instruments having new-style concentric amphenol terminals and plugs; enable users to plug old equipment into new or to use maker's "CL-101" shielded clip lead (see illus-



1115

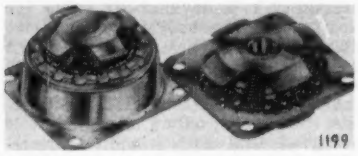
tration) for older equipment having spaced terminals.—*Millivac Instrument Corp., 444 Second St., Schenectady 6, N. Y.*

For more information circle **346** on inquiry card.

MECHANICAL COMPONENTS

Shock Mounts

New "Equiflex" all-metal vibration isolators absorb vertical and horizontal vibrations; are said to have long service life, freedom from drift or



permanent set, and performance unaffected by temperature extremes. They withstand 100-hour salt spray tests. 15-*G* shocks can be sustained without damage and equipment is kept captive up to 30 *G*. Round-cup mount (left) and square-plate mount (right) are both available as "size 1" for light loads to 6 lbs. (instruments, etc.); "size 2" for loads to 14 lbs. (cabinets housing electronic equipment, etc.); and "size 3" for loads to 35 lbs. Each mount is stamped with its load rating in pounds.—*Ucinite Co., Div. United Carr Fastener Corp., Newtonville, Mass.*

For more information circle **347** on inquiry card.

Labeling Tape

New "Write on it" self-adhesive plastic tape, previously available in roll, tablet or book-match form, is now furnished in convenient cut-to-size strips or labels from 1 in. to 6 in. long and from 5/16 in. to 3 in. wide, in a variety of border colors. It can be written on with any dry, blunt point such as a pencil or stylus. Pressure of writing instrument causes writing to appear beneath a layer of transparent plastic. No ink, pencil-lead or crayon is required. Writing is in same color as outside border. Tape resists temperatures from –40 F. to 150 F.; will not curl or discolor with age; can be applied and reapplied without losing adhesiveness. In new form, strips are mounted on smooth-finished polyethylene paper from which they peel off.—*Labelon Tape Co., Inc., 450 Atlantic Ave., Rochester 9, N. Y*

For more information circle **348** on inquiry card.

Corrosive-resistant Filter

New porous "Kel-F" filter medium is completely resistant to all common acids and gases in all concentrations, as well as to common organic chemicals; is said to be unique in that it presents a large surface area, yet does not catalyze decomposition of hydrogen peroxide. Standard porous "Kel-F" filter elements will remove all particles larger than 5 microns in liquid filtration, and much finer particles in gas filtration; can be used at temperatures up to 350 F.; resist

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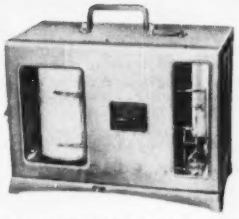

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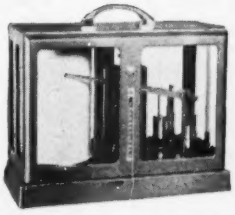

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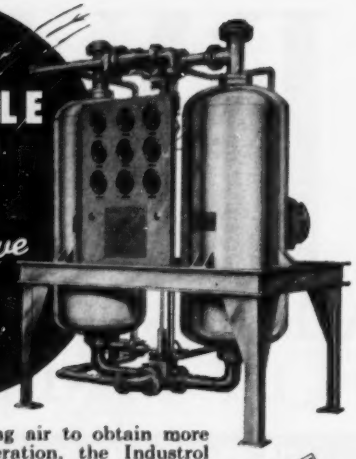
For more information circle **92** on inquiry card.

for DEPENDABLE Instrument Operation You Must Have CLEAN-DRY AIR



When your problem involves drying air to obtain more efficient, dependable instrument operation, the Industrol Dynamic Dehumidifier offers you a practical low cost solution.

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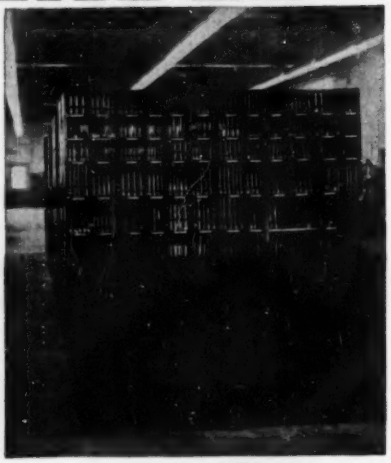

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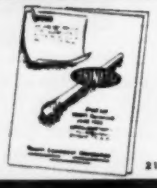

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THERMOWELLS and other Specialties for the Process Industries

For more information circle **94** on inquiry card.

NEW INSTRUMENTS

thermal shock. Tensile strength 900 psi., modulus of elasticity 18,000 psi. Complete filters are available from fractional square foot surface area up to 50 sq. ft. of filter area. Larger units on special order.—*Porous Plastic Filter Co., Glen Cove, N. Y.*

For more information circle **349** on inquiry card.

Air Control Manifold

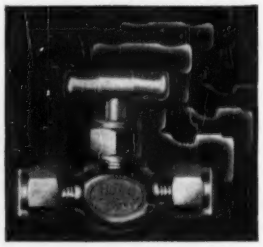
New "Air Control Manifold" combines in one bronze casting 9 in. wide all necessary valves and regulators normally required to control air line pressure: a ¾-in. shut-off valve for closing off air source; a pressure reducing valve; a ¾-in. blow-down valve; check valve; and pressure gage with shut-off valve. Fourteen pipe connections are eliminated. Installation time is cut; only 8 mounting bolts are used; and units are interchangeable, simplifying maintenance.—*Republic Mfg. Co.*, 1930 *W. 77th St., Cleveland 2, Ohio.*

For more information circle **350** on inquiry card.

VALVES

Instrument Air Valves

New small instrument air valves (manufactured by Hoke, Inc.,) are equipped with Crawford "Swagelok" ends (as shown) to provide leakproof



and torque-free seals on instrumentation installation. Present materials: brass, aluminum, steel and stainless steel.—*Crawford Fitting Co.*, 884 *E. 140th St., Cleveland 10, Ohio.*

For more information circle **351** on inquiry card.

Safety-relief Valve

New "Uni-Line 41-W-200 Series" valve is claimed to have advantages over more conventional safety-relief valves: a much higher capacity per size; a free-acting, self-aligning disk; a "floating" guide (readily adjustable for control) which assists in opening and closing action as well as affording an additional self-aligning feature; a disk and disk holder of forged copper alloy. New valves are available in sizes from 1½ in. through 6 in.; are V&W National Board approved design.

—*J. E. Lonergan Co., 2nd and Race Sts., Philadelphia 6, Pa.*

For more information circle **352** on inquiry card.

Midget Solenoid Valves

New midget solenoid valves, no larger than two packs of regular-size cigarettes, operate in any position; feature positive shut-off, low current consumption, optional time-delay, and adjustable by-pass and main flow. Among new types is "K-28," with a built-in time-delay action to prevent immediate opening of valve until oil burner motor gains full running speed.—*General Controls Co., Glendale, Calif.*

For more information circle **353** on inquiry card.

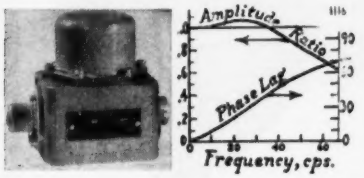
Check Valves

New "Free-flow" check valve features spherical poppet nose and matching seat which assure leak-proof seal because they are self-aligning. Caged poppet gives "lower-than-ever" pressure drop, practically no flow restriction, in non-surge hydraulic systems to 3,000 psi. Standard opening pressure as low as 3 oz.; stronger springs are available so that new units can be used as combination in-line relief-check valves. All combinations of tube and pipe ports; operating temperatures from —65 to 200 F. (higher on order); all metals; sizes ⅛ in. to 1 in.—*Republic Mfg. Co., 1930 W. 77th St., Cleveland 2, Ohio.*

For more information circle **354** on inquiry card.

Servo Valves

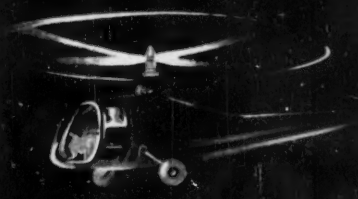
New "Model 500 Electro-Hydraulic Servo Valves" are proportional-type electrically-actuated hydraulic four-way valves featuring no mechanical



linkage. They are designed to control any maximum desired output flow from 0.5 to 8.0 gpm. in hydraulic systems from 1000 to 3000 psi. Standard signal input for full output flow is a differential current of plus-to-minus 8 ma. (lower or higher signal levels available). Frictionless first-stage push-pull hydraulic amplifier requires a continuous oil flow of 0.1 gpm., internally filtered by sintered bronze elements and magnetic traps. Input is a polarized solenoid; output of first stage is a differential hydraulic pressure applied to valve spool in opposition to return springs. Applications include control systems requiring high accuracy such as machine tools or processing units; or requiring high response speed such as guided missiles. Normally, valve input is from a balanced push-pull d-c. amplifier and valve output flow is applied to a piston or hydraulic motor. An electric signal proportional to piston position or motor angular rotation is fed back to amplifier to give a closed servo loop. Loop natural frequencies of 65 cps. can be obtained with an uncompensated amplifier.—*Moog Valve Co., Inc., Proner Airport, East Aurora, N. Y.*

For more information circle **355** on inquiry card.

...thermal sensing unit



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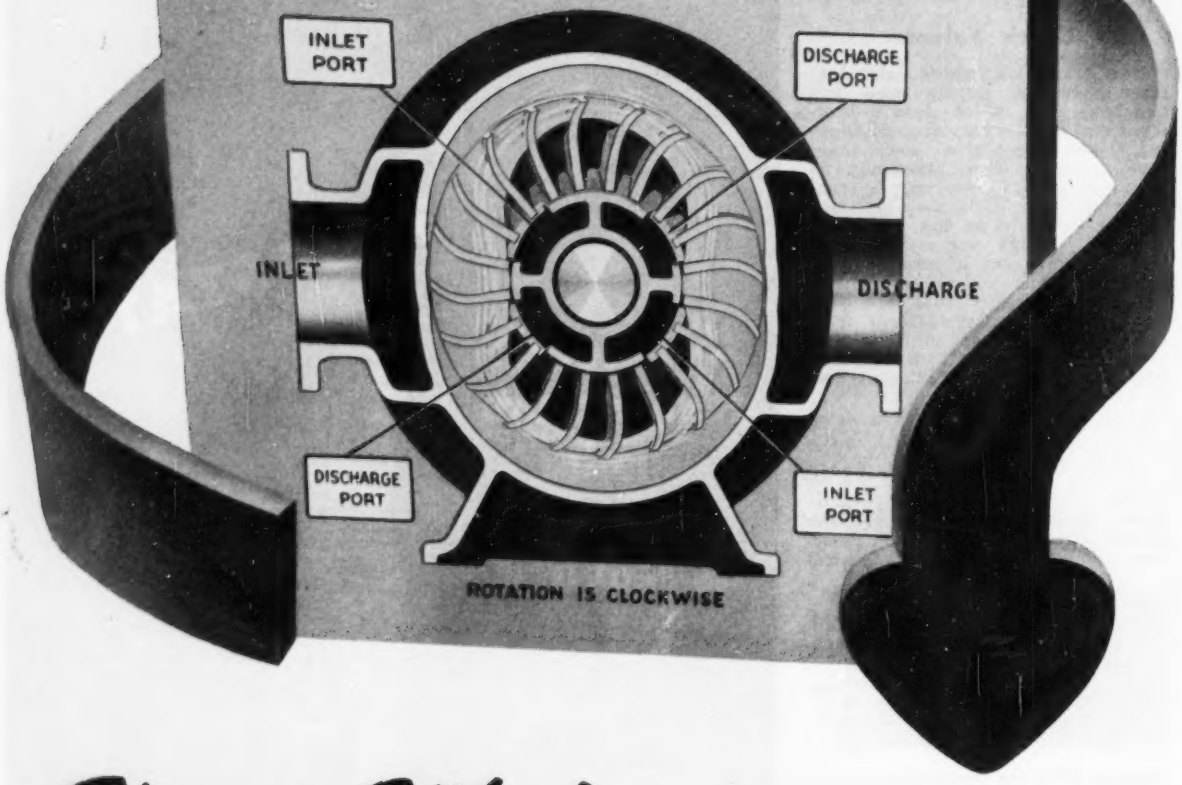
For more information circle **95** on inquiry card.

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters



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®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

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- No internal lubrication to contaminate air handled.
- No internal wearing parts.
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- Non-pulsating pressure.
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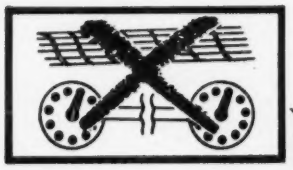

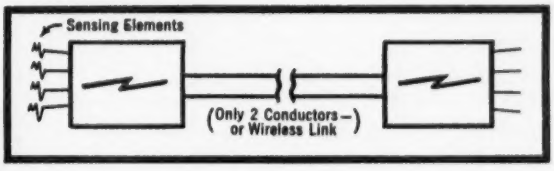

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THE INSTRUMENT INDUSTRY

——*today and tomorrow*

The Instrument Industry—How big is it? How many companies are in it? What is the dollar volume shipped per year? Is it expanding or contracting? What is the outlook?

By RICHARD RIMBACH

THIS report on the Instrument Industry includes the following code classifications of the Census of Manufactures:

Code No. 3576 — *Scales and Balances,* includes weighing devices of all types, including those with automatic computer mechanisms and coin operated scales. Important products of this industry are industrial scales, commercial scales, household and person weighing scales, mailing and parcel post scales, railroad track and motor truck scales, as well as laboratory precision balances.

Code No. 3586 — *Measuring and Dispensing Pumps.*

Code No. 3613 — *Electrical Measuring Instruments,* includes instruments for indicating, measuring and recording electrical quantities and characteristics and includes pocket, portable, panelboard and graphic recording instruments for measuring electricity, such as voltmeters, ammeters, wattmeters, watt-hourmeters, demand meters, and other meters and indicating instruments. This code also includes establishments primarily engaged in manufacturing meter transformers, and analyzers for testing the electrical characteristics of internal combustion engines, radio apparatus, etc.

Code No. 3811 — *Scientific Instruments,* includes laboratory, scientific and engineering instruments such as nautical, navigational, aeronautical, surveying, drafting, mathematical instruments, and instruments for laboratory work and scientific research.

Code No. 3821 — *Mechanical Measuring Instruments* for indicating, recording, measuring, and controlling temperature, pressure, mechanical motion, rotation, flow, liquid level, humidity, density, acidity, alkalinity, and combustion; dial pressure gages; physical property testing apparatus such as hardness, tension, compression, torsion, ductility, and elasticity testing apparatus; and instruments for household and office use such as thermometers, barometers and rain gages.

Code No. 3831 — *Optical Instruments and Lenses,* includes the products of establishments primarily engaged in grinding optical lenses and prisms, and in manufacturing microscopes, telescopes, field and opera glasses, and related optical instruments such as refractometers, spectrometers, spectroscopes, colorimeters, polariscopes, and optical measuring instruments. It does not include the manufacture of eyeglass lenses, frames or fittings.

Code No. 3861 — *Photographic Equipment and Supplies,* includes still cameras, motion-picture cameras, projection apparatus, photocopy and microfilm machines; equipment such as plate and film holders, tripods, film reels, developing tanks and machines, enlargers, and motion-picture screens; and supplies such as sensitized film, paper, and plates; and prepared developers, fixers, and toners.

Code No. 3871 — *Watches, Clocks and Parts,* except Watchcases, includes electric clocks, watches, mechanisms for clockwork-operated devices, and clock and watch parts. Establishments primarily engaged in assembling clocks and watches from purchased movements and cases are included.

The information assembled from the Census of Manufactures is tabulated below. Actually, the annual value of instruments and allied products shipped is much greater because many devices are not reported separately but are

TABLE 1. ANNUAL DOLLAR VOLUME OF INSTRUMENTS SHIPPED, AS REPORTED BY THE CENSUS OF MANUFACTURES

Product with Industry Code in Parenthesis	*Dollar Volume, in Thousands*					
	1939	1947	1949	1950	1951	1952
Scales & Balances (3576)	14,350	54,542	54,777	63,097	77,773	78,652
Measuring & Dispensing Pumps (3586)	44,286	125,052	93,094	121,793	132,003	147,611
Electrical Measuring Instruments (3613)	41,979	153,380	123,625	165,844	233,096	299,006
Scientific Instruments (3811)*	42,251	126,703	113,690	188,874	323,167	488,325
Mechanical Measuring Instruments (3821)*	89,380	376,473	408,298	562,672	651,006	846,073
Optical Instruments & Lenses (3831)*	8,690	36,081	43,482	59,524	94,843	122,695
Photographic Equipment (3861)*	133,052	440,134	432,857	506,787	581,344	696,544
Watches & Clocks (3871)	81,475	341,199	258,737	341,423	366,054	361,504
TOTALS	455,463	1,653,564	1,528,560	2,010,014	2,459,286	3,040,410

* The 1951, 1950 and 1949 data for Industries 3811, 3821, 3831 and 3861 are not strictly comparable with data shown for 1947. This is due to the misclassification in 1947 of establishments and to the change in plant definition after 1947 for some establishments. On a comparable basis in terms of value added by manufacture, it is estimated that the 1947 figures for Industry 3831 should be approximately 50% greater and about 5% less for Industry 3811.

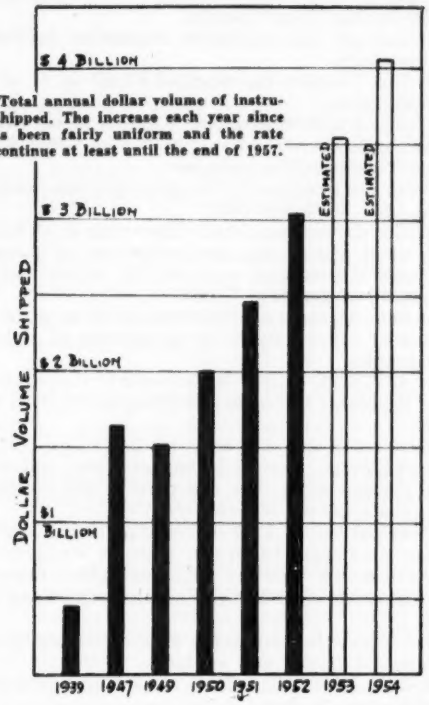

Fig. 1. Total annual dollar volume of instruments shipped. The increase each year since 1949 has been fairly uniform and the rate should continue at least until the end of 1957.

included in larger classifications and, therefore, cannot be included in the following tabulation. Some of the devices that are not included in the tabulation because they fall in larger classifications are:

1. Dimensional gages and gage blocks, balancing machines, micrometers and verniers; plug, ring, snap and thread gages; and other measuring tools (which are reported in the Census under cutting tools, jigs, fixtures, etc.).
2. Electronic computing and related machines.
3. Some special transformers used in instruments.
4. Electrical control apparatus including electronic inspection and gaging devices and positioning controls.
5. Electronic tubes used as replacements in instrumentation.
6. X-ray and therapeutic apparatus used in research and industry.
7. Laboratory glassware (reported in the Census under pressed and blown glassware).
8. Time-recording clocks, time-stamping machines and watchmen's clocks.
9. Recording chart paper not sold by instrument manufacturers.

In 1939 the value of the products shipped by the instrument industry (Table 1) was $455,463 thousand. In the next ten years there was an *increase* of $1,073,097 thousand, while in the next two years the increase was almost the same as in the previous ten ($930,726 thousand). For the ten years (1939-1949) the increase was at a rate of about $100 thousand a year, while in the next three years the rate was about $500 *thousand a year.*

In 1939 the industry employed 72,451 (Table 2). In 1949 the number of employees increased by 55,930; while in the next two years the increase in employment was 43,924.

Interest in Instrument Industry Increases

Interest in the instrument industry has increased rapidly in recent years, as evidenced by the fact that many new companies as well as companies not now manufacturing instruments are entering this field. There appears to be three reasons for this activity and the rapid growth of the market:

1. The need for a higher return on capital investment in every industry.
2. The assurance of greater long-term stability.
3. The desire for more diversification of product.

The importance of increasing output while decreasing costs is the primary function of engineers and executives. The ability of instruments to do this has been so well demonstrated that no technical or financial journal dares neglect this new key field of instrumentation.

In the July 18th issue of *Business Week*, and in the July 24th issue of *U. S. News-World Report*, the Bankers Trust Company states the following in their full-page advertisement:

> "Accompanying the three-fold growth of instrument manufacturing plants in recent years, is an impressive upward sales curve—from $455 million in 1939 to approximately $2½ billion in 1951."

The National City Bank in its October *Monthly Letter* devotes 2 pages to the importance of instruments in an article entitled "Frontiers of Industry." This article begins as follows:

> "One of the many signs of this country's continuing progress is the rapid emergence in recent years of a group of new industries making laboratory and control equipment. Development of such apparatus received great impetus during World War II in connection with the country's intensified program of scientific research for creating advanced military weapons. At the same time, the new equipment found a place in industry to aid in turning out more and better products despite wartime shortages of skilled workers."
>
> "Suppling these new tools to industry has itself become a sizeable industry—or group of highly specialized industries. During the past several years many new companies have been organized, most of them family or closely-held corporations that do not release financial information. A limited number, however, have begun publication of regular statements or filed registration statements

Table 2. Average Number of Production Workers, as Reported by the Census of Manufactures

Product with Industry Code in Parenthesis	1939	1947	1949	1950	1951	1952
Scales & Balances (3576)	2,839	4,874	4,385	4,443	5,166	6,683
Measuring & Dispensing Pumps (3586)	5,054	8,844	5,740	6,721	7,702	10,569
Electrical Measuring Instruments (3613)	6,976	16,086	11,403	14,263	19,635	30,545
Scientific Instruments (3811)	6,529	15,023	10,706	16,425	23,952	41,494
Mechanical Measuring Instruments (3821)	15,075	40,937	34,697	45,625	46,741	75,426
Optical Instruments & Lenses (3831)	2,209	5,228	5,327	6,769	9,699	13,552
Photographic Equipment (3861)	16,434	36,273	32,130	30,470	33,827	50,244
Watches & Clocks (3871)	17,335	30,237	23,993	24,618	25,583	28,437
TOTALS	72,451	157,542	128,381	149,334	172,305	256,950

with the Securities & Exchange Commission as a result of the widening distribution of their stock ownership or their need to attract additional capital—equity or borrowed. A group of twenty-five such concerns shows combined sales in 1952 amounting to $277 million, a gain of 22 percent over 1951. This contrasts with a gain of only 3 percent for the manufacturing industries as a whole.

"The marked strides made by the younger companies does not of course mean that the large and old-established companies interested in the same fields are idle. Leading organizations which also have been spending vast sums for research and development work comprise a long list including numerous well-known companies, each having a total sales exceeding $100 million annually, such as Admiral, Allis-Chalmers, American Telephone, Bendix Aviation, Burroughs, General Electric, International Business Machines, International Telephone, Minneapolis-Honeywell, Motorola, National Cash Register, Philco, Radio Corporation, Raytheon, Remington-Rand, Sperry, Sylvania, Westinghouse Electric and Zenith."

The American Market

The Census of Manufactures has recently issued the 1952 Annual Survey of Manufactures. This Annual Survey shows that the annual dollar value of instrument shipments reached a total of over $3 billion last year, an increase of $50 million over 1951.

In the annual report of Beckman Instruments, Inc. to stockholders for the 1953 fiscal year ending June 30th, Dr. Beckman pointed out that "instruments are playing essential roles in the technological revolution that is resulting from application of automatic controls to industrial processes. This revolution is in an early stage, and the instrument industry should expand far beyond its present size as automization proceeds."

Further growth of the instrument industry is indicated by recent plant expansions and acquisitions as reported in *Instrument Manufacturing*:

Aerovox Corp. purchased Acme Electronics, Inc. of Pasadena and Cinema Engineering of Burbank.

American Car & Foundry recently entered the industry with the purchase of Avion Instruments.

American Meter has built a new 48,000 sq. ft. plant at Nebraska City, Neb.

Baker & Company has started construction of a $2½ million plant at South Newark.

Beckman Instruments has announced plans for a $2 million plant.

Bendix Aviation has added to its present instrument holdings by buying Ultra-Viscosin.

Bristol Company has expanded production facilities for printing charts.

Builders Iron Foundry has acquired 87,000 sq. ft. of manufacturing space.

Clevite Corp., a new corporation, functions as the parent organization for Cleveland Graphite Bronze, Brush Electronics and Transistor Products, Inc.

Clare Relay has completed a new relay manufacturing plant in Chicago's northwest side.

W. M. Chace Co. has completed a new wing on their Detroit plant, which will increase production over 12 percent.

Consolidated Engineering acquired the vacuum equipment department of Eastman Kodak.

DuMont Labs opened a new Instruments Divn. plant having an area of 118,000 sq. ft. for production of cathode-ray oscillographs.

Thomas A. Edison bought Measurements Corporation.

Electric Regulator has made a 2100-sq.-ft. addition to their plant.

Elgin National Watch will diversify into 2 new fields: miniature electronic components and precision instruments.

General Electric will build a new plant to manufacture electronic controls near Waynesboro, Va.

G. M. Giannini built a $500 thousand plant at Pasadena.

Gow-Mac Instrument has a new plant at Madison, N. J.

G-V Controls has acquired additional plant capacity for manufacturing of hermetically sealed relays and thermostats.

Hamilton Watch has organized a new division to develop, produce and market new products.

Helipot Corp., South Pasadena, has set up a new plant at Mountainside, N. J.

Hickok Electrical Instrument recently completed a new assembly plant in Cleveland.

High Vacuum Equipment Corp., Hingham, Mass. was recently organized.

Instrument Motors has moved to new and larger quarters in Stamford, Conn.

Liston-Becker has consolidated production facilities for gas analyzers in a new plant at Stamford, Conn.

Micro Divn., Minneapolis-Honeywell, has put up a 10,000-sq.-ft. building at Warren, Ill.

Perkin Engineering, El Segundo, has moved into a new 10,000 sq. ft. plant.

Powers Regulator has completed a $1½ million plant at Skokie, Ill.

Resistance Products, Harrisburg, Pa., has doubled its manufacturing space.

Servomechanisms, Inc. has formed a new component division

Partial List of Manufacturers of Industrial Laboratory and Control Equipment Which Began Publication of Financial Statements Since World War II

Company	*Location*	*Principal Products*	1952 *Sales (Thousands)*
Ampex Corporation	Redwood City, Cal.	Magnetic recording equipment for music, aircraft, industrial vibration	$ 3,549
Applied Research Laboratories	Glendale, Cal.	Optical-electronic high-speed chemical analysis instruments	2,954
Audio Devices, Inc.	New York, N. Y.	Sound recording discs; magnetic tape; magnetic film	2,339
Beckman Instruments, Inc.	S. Pasadena, Cal.	Spectrophotometers; pH meters; radioactivity measuring instruments	14,400
Cenco Corporation	Chicago, Ill.	Physics and chemistry laboratory apparatus; high-vacuum pumps	12,015
Commercial Controls Corp	Rochester, N. Y.	Tape-controlled writing, mailing, etc., machines; electrical heating	6,090
Consolidated Engineering Corp.	Pasadena, Cal.	Industrial electronic control instruments; mass spectrometers	8,001
Federal Electric Products Co.	Newark, N. J.	Low-voltage electrical distribution and control equipment	16,761
Fischer & Porter Co.	Hatboro, Pa.	Mechanical and electrical flow meters; process controls	7,355
G. M. Giannini & Co.	Pasadena, Cal.	Control components for aircraft, guided missiles; precision instruments	4,709
Hagan Corporation	Pittsburgh, Pa.	Metering equip.; automatic control devices; water-softening chemicals	15,945
I-T-E Circuit Breaker Co.	Philadelphia, Pa.	Circuit breakers, switchboards, rectifiers, radar and TV equipment	65,033
La Pointe Electronics, Inc.	Rockville, Conn.	Electronic equipment; precision parts for TV and aircraft	3,848
Norden Laboratories Corp.	White Plains, N. Y.	Aircraft flight and fire control instruments; electrical computers	3,252
Nuclear Inst. & Chemical Corp.	Chicago, Ill.	Equipment to detect, measure and utilize radioactive materials	1,178
Pavagon Electric Co.	Two Rivers, Wis.	Automatic time controls; motors, switches, other electrical equipment	4,524
Reeves Soundcraft Corp.	New York, N. Y.	Sound recording discs and tape for motion pictures and industry	3,365
Robertshaw-Fulton Controls Co.	Greensburg, Pa.	Automatic temperature and pressure recorders and controls	50,030
Servomechanisms, Inc.	Garden City, N. Y.	Automatic electro-mechanical control instrumentation and equipment	10,152
Taylor Instrument Cos.	Rochester, N. Y.	Meters and controls for temperature, pressure, humidity, liquid flow	21,623
Telecomputing Corp.	Burbank, Cal.	Electronic instruments for computing and analyzing scientific data	1,665
Tracerlab, Inc.	Boston, Mass.	Radioactive chemicals; nucleonic instruments for handling and control	12,275
Ultrasonic Corporation	Cambridge, Mass.	Sound wave equipment; guided missile navigation computers	2,108
Victoreen Instrument Co.	Cleveland, Ohio	Instruments to measure X-radiation in medicine and industry	1,803
Vitro Manufacturing Co.	Pittsburgh, Pa.	Electronic and mechanical equipment; pigments; uranium processing	2,240

TABLE 3. COMPARISON OF NUMBER OF ESTABLISHMENTS AND PRODUCTION WORKERS AS REPORTED IN THE 1939 AND 1947 CENSUS OF MANUFACTURES

Industry and Code Number	1939		1947	
	No. of Establishments	*Production Workers*	*No. of Establishments*	*Production Workers*
Scales & Balances (3576)	56	2,839	75	4,874
Measuring & Dispensing Pumps (3586)	38	5,054	52	8,884
Electrical Measuring Instruments (3613)	59	6,976	154	16,086
Scientific Instruments (3811)	125	6,529	216	15,023
Mechanical Measuring Instruments (3821)	227	15,075	463	40,937
Optical Instruments & Lenses (3831)	31	2,209	114	5,228
Photographic Equipment (3861)	160	16,434	366	36,273
Watches & Clocks (3871)	64	17,335	194	30,237
Totals	760	72,451	1,634	157,542

to produce servo and instrument motors at Westbury, Long Island.

Standard Instrument, New York City, was organized to take over General Power Plant Corp. and Ace Instrument Corp.

Texas Instruments has just completed a $1 million plant at Dallas.

Victoreen has acquired Pioneer Electronics.

Further growth of the instrument industry is also indicated by the trend in increased use of instrumentation. The following appeared in the October 5th issue of *Chemical & Engineering News*:

> "The trend toward greater use of instruments for industrial processing has resulted in doubling, since 1935, the rate of instrument buying for new plants. The proportion of instrumentation on plant equipment has risen similarly—from about 5 percent in 1939 to about 20 percent now—and the trend is still upward."

INVESTMENT FOR RESEARCH

The investment made for research by the instrument industry was disclosed by Kenneth Andersen, Executive Vice President, Scientific Apparatus Makers Association, at the recent Chicago Instrument Exhibit:

> "The most recent data on this subject released a few months ago by the Department of Defense and Bureau of Labor Statistics show that manufacturing industry in this country appropriates two cents of each sales dollar to research and development. The figure for the instrument industry alone is six cents."

It will be noted that the instrument industry spends 3 times as much as the average of all industry. This investment in research will assure a steady increase in the size of the instrument industry.

This fact is important for two other reasons—(1) it shows the progressive outlook of the firms in the instrument industry and (2) in no industry is the money spent on research so quickly translated into practical use. The first product of the research dollar is a "new instrument." As shown in Table 4, 1675 new instruments were reported and reviewed in *Instruments* in 1953. Each one holds forth the promise of a new prospective measurement or a new control action to every industrial firm in the nation.

TABLE 4. NUMBER OF NEW-PRODUCT ITEMS REPORTED ANNUALLY IN THE NEW INSTRUMENTS SECTION OF *INSTRUMENTS* MAGAZINE

Year	*New Instruments*	*No. of companies listed in the Instruments Index*
1928	84	
1929	106	
1980	133	
1931	233	
1932	283	
1933	308	
1934	311	
1935	306	692
1936	317	
1937	313	
1938	370	
1939	363	854
1940	291	843
1941	246	933
1942	266	964
1943	280	1013
1944	312	1044
1945	393	
1946	647	1264
1947	660	1307
1948	636	
1949	798	1361
1950	1063	
1951	791	1517
1952	1141	
1953	1675	1889

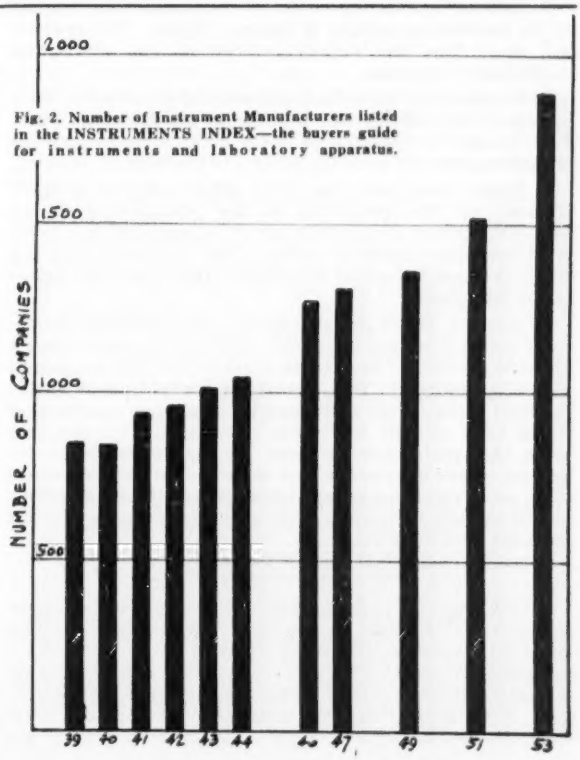

Fig. 2. Number of Instrument Manufacturers listed in the INSTRUMENTS INDEX—the buyers guide for instruments and laboratory apparatus.

TABLE 5. PERCENT INCREASE IN DOLLAR VOLUME OF INSTRUMENTS SHIPPED IN 1952 OVER 1951

Product with Industry Code in Parenthesis	*Percent Increase or Decrease*
Scales & Balances (3576)	1.1
Measuring & Dispensing Pumps (3586)	11.8
Electrical Measuring Instruments (3613)	28.2
Scientific Instruments (3811)	51.2
Mechanical Measuring Instruments (3821)	29.8
Optical Instruments & Lenses (3831)	29.4
Photographic Equipment (3861)	19.7
Watches & Clocks (3871)	−0.1
Average	23.6

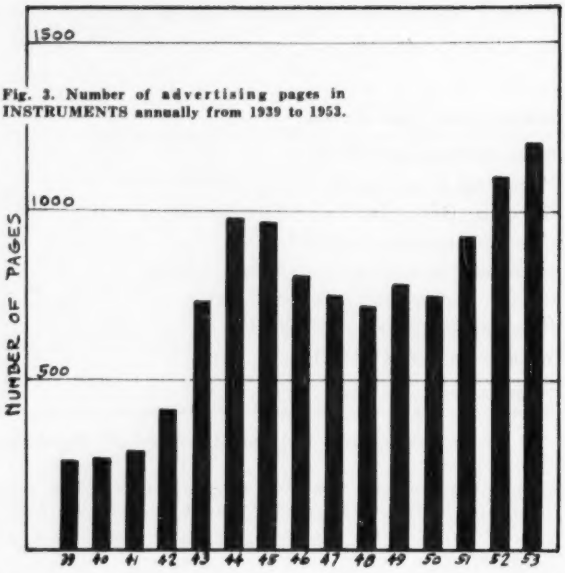

Fig. 3. Number of advertising pages in INSTRUMENTS annually from 1939 to 1953.

MARKET OUTLOOK

There are eight sound reasons why the instrument field is one which manufacturers of instruments (and of related products) should find of current and future importance:

1. Instruments are the next step beyond machines. A brilliant future for instruments and apparatus for measurement, analysis, inspection, testing, computing, and automatic control is foreseen.

2. The need for instruments stems from a desire to obtain better yields of purer products from poorer raw materials, with less capital investment and less manual labor.

3. Pressure for low-cost production increases. Never has it been so necessary to offset fixed costs by increased manufacturing efficiencies. In the final analysis, the object of all instruments is cost reduction either through direct savings, prevention of destruction of the equipment under control, or saving of losses through rejection of unsatisfactory product.

4. To produce on a lower cost-plane will require the installation of automatic machinery; automatic measurement and control devices will be needed in greater quantity.

5. Industry is entering an era of instrumentation marked by the keenest competition in business history. The rewards will go to those who employ instruments and automation to the best advantage.

6. Research activities, both private and government, have increased considerably and promise to increase even more. This increase in research calls for a considerable increase of instruments and controls, which are the tools of research.

7. Higher labor costs can mean either a higher or lower standard of life—depending on the productivity of the economy. Modern productivity can be increased by automatic machinery and automatic control of the machinery. The latter is the new industrial revolution, which has only begun in the last decade.

8. Another factor which assures an expanding instrument industry is that industrial productivity must increase about 45 percent in the next ten years to maintain a balanced expanding economy. This increase is brought about by the insistent demand for a constantly improving standard of living by a steadily increasing population. This can only mean that each producer must assume responsibility for greater output if we are to hold our standard of living where it is, and for still greater output if our living standards are to continue improving at the accustomed two to two and one-half percent a year.

EFFECT OF LABOR COSTS

In addition, the constant unceasing pressure of higher labor costs inevitably means more instrumentation. This does NOT mean displacement of labor by automation—a concept that has been proved false in its entirety during the last decade. It DOES mean a labor force with higher level of technical skill. The total labor bill will be *higher* —but the productivity increase occasioned by greater use of instrumentation will mean (1) less cost per unit product, (2) higher efficiency, (3) a higher standard of life. This is the promise offered by INSTRUMENTATION.

EFFECT OF GOVERNMENT SPENDING

Many companies, not now in the instrument business, have Government classified contracts. As this information is declassified many of these companies will be interested in the industrial market. Further, as the government comes closer to a balanced budget by decreasing expenditures, the many instrument companies with government contracts and sub-contracts MUST find other markets.

No manufacturer can refuse to purchase a product whose use means greater profit and less cost per unit produced. This is the promising frontier of instrumentation—there are limitless applications of instruments that can mean higher production at reduced cost.

PROMOTING THE MARKET

The tabulated figures prove that a vast market for the products of the American instrument industry already exists—and a vaster one awaits. The basic problem is how to reach the market.

In any sales work, there is no substitute for a good salesman. But there is a basic difference between the salesman for an instrument company and one for most other fields. The former is more than a salesman; he is an application engineer; he must tailor his product for a new application in a new plant under new conditions. His job is tough; but the rewards are more than monetary. There is a peculiar satisfaction in solving efficiency and production problems —enough satisfaction to produce thousands of dedicated imaginative men who devote their time to solving application problems in large and small plants across the nation.

All technical magazines now carry promotional advertisements of instrument companies, seeking out new customers. Most of the original leads to the customer arise from inquiries from such trade journals. For example, in 1953 alone more than 110,000 reader inquiries were received by *Instruments* and forwarded to the instrument manufacturers.

For twenty-five years, the full-time professional and industrial instrument men of the country have been using the magazine *Instruments*, which is today the country's leading industrial-instrument magazine. The many services of the magazine (new instruments, new manufacturers' literature, application articles, etc.) are world famous. This magazine is the direct route to the country's largest instrument users. In recognition of the growing importance of automatic control, the name of the magazine is being changed to *Instruments & Automation*.

Nuclear Reactors for Industry and Research

REACTOR CONTROL

A nuclear reactor is controlled by using four channels—the Counting Rate Channel, the Micromicroammeter Channel, the Period Channel, and the Safety Channel—to position the control rods within the reactor. The channels are brought into play at various power levels. This is the fifth installment in this series.

by CLINTON G. GOSS
Radiation Counter Laboratories, Inc.

BASIC MEASUREMENT on which control of a reactor depends is that of neutron intensity, or neutron flux. Either a human operator or a servomechanism uses this information to position the control rods in the reactor. Pulling the control rods out increases the power level; pushing them in decreases the power level.

At low neutron rates, counting technique must be used—that is, secondary ionization events produced by neutron collisions in a neutron-sensitive chamber are counted individually. At higher neutron rates the average signal current is large enough to be measured directly as a d-c. signal.

Three channels are used in measurement of the neutron intensity—(1) the Counting Rate Channel, (2) the Micromicroammeter Channel, and (3) the Log n, or Period, Channel. A fourth channel, the Safety Channel, is brought into play when the reactor power level exceeds design ratings.

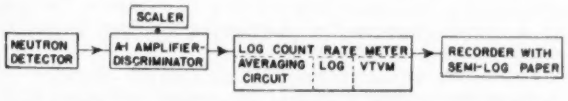

Fig. 5-1. Basic Counting Rate Channel for low-level neutron intensity. The indicator has a log-type scale, as shown in Fig 5-2.

Consider a reactor that has been properly charged with uranium. Assume that its moderator and reflector are in place, all its regulating, shim, and safety rods are pushed in, and all experimental and beam holes into the reactor core are either closed or properly blocked off. (If they are not properly attended to, a monitoring instrument will either shut the reactor down or sound a loud alarm.) After loudspeaker announcements, "Reactor going up to full power in five minutes," etc., the operator withdraws the safety rods. The control or regulating rod is usually the last one to be pulled out.

As the rods are withdrawn, the Counting Rate Channel (Fig. 5-1) is the first to record changes, long before the reaction becomes self-sustaining.

Counting Rate Channel

For counting individual neutrons a detector is used that produces larger pulses for neutrons than for other radiations such as beta and gamma rays. This detector can be a proportional counter filled boron trifluoride or a fission chamber consisting of a pair of plates coated with uranium-235.

Pulses from the neutron detector are amplified in a Linear Amplifier of the Bell Jordan A-1 type (Fig. 5-1) after the smaller pulses (caused by beta and gamma rays) are rejected by the A-1 discriminator. Thus only neutron-produced voltage pulses are amplified by the A-1 amplifier and then counted on the scaler. The amplified pulses are fed also to a Log Count Rater Meter, which produces a voltage to operate a strip recorder with four-cycle logarithmic paper.

The indicator in the Log Count Rate Meter (Fig. 5-2) has a log-type scale because the rate of neutron in-

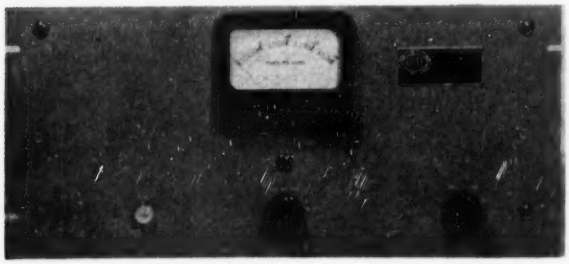

Fig. 5-2. Oak Ridge Logarithmic Count Rate Meter for recording neutron intensity from neutron counter.

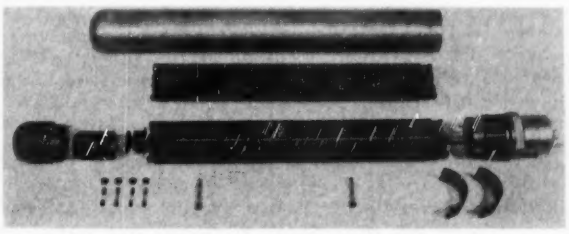

Fig. 5-3. Compensated ionization chamber.

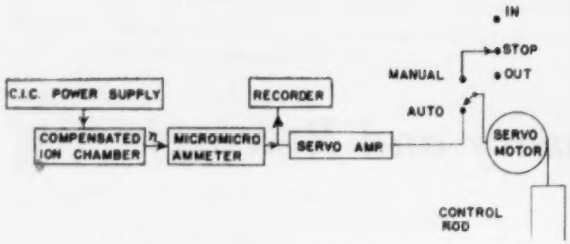

Fig. 5-4. Basic Micromicroammeter channel.

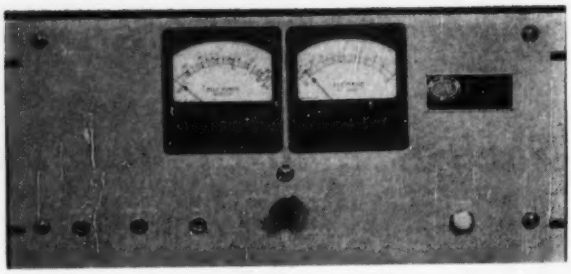

Fig. 5-6. The Oak Ridge Log n Amplifier, which receives its signal from a compensated ionization chamber.

cidence varies over a wide range. In this type of indicator the pointer is at zero for counts less than one count per second. At ten counts per second the pointer advances 22 degrees (¼ scale); at 100 counts the pointer advances 44 degrees (½ scale); at 1000 counts the pointer advances 66 degrees (¾ scale); at 10,000 counts the pointer is at full-scale deflection.

It is convenient to record the output of the Log Count Rate Meter on a recorder equipped with four-cycle semi-log paper. As a reactor with the control rods pulled out enough to produce an effective neutron self-breeding ratio of greater than 1.0000 increases in power level (or in the number of neutrons formed per second) with an exponential characteristic at low power levels, a straight line is recorded on the logarithmic chart. Measurement of the slope of this line gives the *pile period*, or the time necessary for the reactor power level to increase by a factor of approximately 2.718.

Note that the Counting Rate Channel (Fig. 5-1) consists of a neutron-sensitive detector, an A-1 amplifier, a Log Count Rate Meter, and a recorder for pile period.

Compensated Ionization Chambers

For start-up, the fission chamber is placed in or near the reactor core. When the Counting Rate Channel reaches the top of its range, the two other channels (Micromicroammeter and Period Channels) reach their operating level, the fission chamber is withdrawn to a region of lower neutron flux, and attention is concentrated on the Micromicroammeter Channel and the Log n Channel. These channels receive their signals from a *compensated ionization chamber.*

A compensated ionization chamber (Fig. 5-3) resembles three teacups that are nested together. The front cup is connected to a source of positive voltage; the rear cup to a source of negative voltage; the signal current flows from the center cup. The surfaces between the two front cups are treated with boron-10 so that this volume of gas is sensitive to neutrons and gamma rays. The surfaces between the two rear cups are untreated so that this volume is sensitive only to gamma rays. Owing to the opposite polarities on the outside cups and a small volume adjustment, the effect of the gamma rays can be neutralized; the signal current is then proportional only to the neutron flux. As the gamma contribution at constant power is small compared to the neutron contribution, the volume adjustment is not critical for general usage.

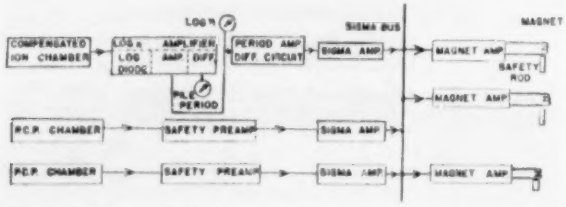

Fig. 5-5. Log n, or Period, Channel (Top), and safety Channel (bottom).

In theory, these ionization chambers are simple. In practice, their design is the result of much research in material selection and repeated use in high flux-densities; their assembly to maintain the proper insulation resistance to work over a current range of more than a million to one is an art.

The normal current range of these chambers is from about 10^{-10} ampere to about 2×10^{-4} ampere at 600 volts collection potential. Leakage with 1000 volts applied to both front and back cups is less than 10^{-12} ampere. The neutron sensitivity is about 3×10^{-15} amp. N^{-1} $cm.^{-2}$ $sec.^{-1}$. A special power supply is used with compensated chambers.

The Micromicroammeter Channel

The Micromicroammeter Channel is shown in Fig. 5-4. It consists of a compensated ionization chamber and power supply, a galvanometer and, perhaps, a servomechanism to position the control rods automatically. A light-beam galvanometer can be used, but has several serious disadvantages. An electronic galvanometer, though more complex, has an output which can be recorded easily and which is suitable for operation of the servomechanism. This channel, being the most precise channel with linear response, is normally used for holding the reactor power-level constant during experiments requiring a non-changing source of neutrons. An instrument is available with full-scale ranges from 10^{-9} to 2×10^{-6} ampere which, modified by a shunt, allows full-scale ranges to 2×10^{-4} ampere. The use of a servomechanism for maintaining constant power is convenient but not necessary.

Even with normal servo control, manual operation is desirable for certain phases of the reactor operation, such as start-up, control-rod calibration, power level changes, etc. During manual operation it is desirable that the rod motors be started, stopped, and reversed without use of arcing relays on the power lines, which cause electrical interference pulses in the instruments used for experiments.

The disadvantages of the Micromicroammeter Channel are:

1. As the channel is linear, the shunts on the galvanometer must be changed a number of times; during the switching transient the meter is not indicating the reactor power level.

2. As we are observing an exponential increase on a linear scale, the rate of change of the output seems to vary with scale position and is not necessarily associated with the rate of increase of a few seconds before.

Therefore, it is apparent that it is desirable to have another logarithmic-scale instrument that can operate at higher power levels than the Log Count Rate Meter. This instrument is called the Log n Amplifier.

The Log n Channel

The Log n, or Period, Channel varies from one installation to another. In its simplest form, it consists of a compensated ionization chamber and power supply, a Log n

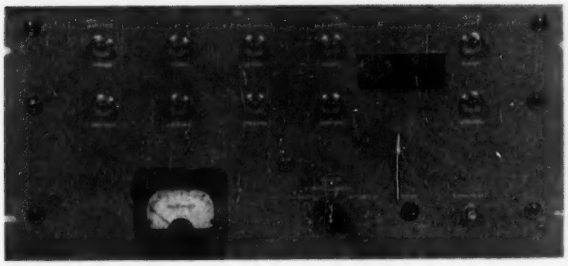

Fig. 5-7. The Oak Ridge Sigma Amplifier, which receives its signal from either a Period Amplifier or a Safety Preamplifier.

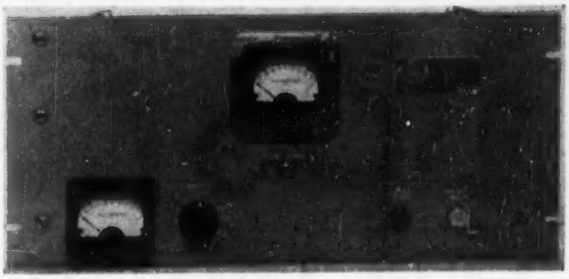

Fig. 5-8. The Oak Ridge Magnet Amplifier, which provides current for the locking magnet and a circuit for rapidly reducing the magnet current without arcing.

Amplifier, a Sigma Amplifier and Sigma Bus, and some Magnet Amplifiers (Fig. 5-5).

After the reactor has increased in power level to the point where the Log n Amplifier is indicating, the operator turns his attention to the outputs of the Log n Amplifier. Fig. 5-6 illustrates the Oak Ridge Log n Amplifier.

One output is the logarithm of the power level. This is comparable to the Log Count Rate Meter (Fig. 5-2) except that this instrument has a range of three million to one instead of ten thousand to one. With normal adjustments the current range is from 5×10^{-11} to 1.5×10^{-4} ampere. However, a standard modification for checking chamber leakage permits indication down to 10^{-13} ampere. For the second output, the Log n Amplifier takes the time derivative (or rate of change) of the logarithm of the power level and indicates it on a meter, the label of which is "Pile Period" (Fig. 5-5). The pile period is the number of seconds necessary for the reactor power level to change by a factor of e (2.718, approximately). Negative periods from infinity to 30 seconds, and positive periods from infinity to 3 seconds are indicated. The longest usable period indication is about 100 seconds.

The operator is careful to keep the reactor on relatively long periods so that the reaction is easily controllable. If the reactor power level is allowed to go too high, the safety circuits insert all rods rapidly (scram the pile), and the whole start-up process must be repeated from the beginning.

In some cases it is advisable to permit the operator to use only the longer periods to bring the reactor power level up to the desired value. Then the output of the Log n Amplifier is fed to a Period Amplifier which, through Sigma Amplifiers and Magnet Amplifiers (Fig. 5-5) shuts the reactor down if the power starts increasing at a rate above that which is permissible, even though the actual power level may be a thousandth or a hundred thousandth part of the permissable power for the reactor design. Sometimes, Period Amplifiers are not needed because the pile-loading of uranium is so carefully controlled that short periods cannot be obtained even with all the rods pulled out. Fig. 5-7 shows the Oak Ridge Sigma Amplifier. Fig. 5-8 shows a Magnetic Amplifier.

The Safety Channel

If, through servo failure or other accident, the reactor power level exceeds the design-power level by a certain small percentage, the reactor is shut down by immediately dropping or inserting all safety, shim, and control rods into the reactor. It usually is most convenient and reliable to drop most of these rods by stopping the current in an electromagnet. If the current must be stopped rapidly, it must have been flowing through hard vacuum tubes that can be cut off by the application of negative voltage to the control grids.

The instrument which supplies the current for a given magnet and which has the tubes for rapidly reducing the current in the magnet without arcing is known as the Magnet Amplifier (Fig. 5-8). Usually three or more control and safety rods are used to control the reactor. Each rod has its magnet, which is fed by a Magnet Amplifier supplying approximately 50 ma.

All of the signal inputs of the Magnet Amplifiers are connected by a series of cables known as the Sigma Bus, which obtains its name from being connected to the outputs of all the Sigma Amplifiers. (Fig. 5-5). The Sigma Bus is held at 37 volts by the Sigma Amplifiers; any appreciable increase or decrease in the Sigma-Bus potential reduces the current output of the Magnet Amplifier to zero.

If there is no need to drop the rods rapidly, the Magnet Amplifiers can be replaced with relays of a carefully selected type. But, because of the inductive load, special care must be taken that the circuit is actually opened; an arc across improperly designed or selected relay contacts only subtracts twenty volts from the supply voltage and does not stop the current.

The Period Amplifier feeds its output into a Sigma Amplifier, and thence to the Magnet Amplifiers via the Sigma Bus. Sigma Amplifiers are used also with neutron-sensitive chambers and Safety Preamplifiers to shut the reactor down if the power level exceeds its rating. The Safety Preamplifier is a carefully designed cathode follower.

The neutron-sensitive chambers are known as Parallel Circular Plate (or P.C.P.) Chambers because of the shape and arrangement of the plates. P.C.P. Chambers resemble compensated chambers in design characteristics and construction materials, but lack compensation for gamma flux.

An important safety feature in designing a circuit to fail safe in the system of power supplies, ion chambers, Log n, Period, Sigma, Safety, and Magnet amplifiers is the extensive use of direct coupling in the concept of electronic circuitry, allowed voltage ranges, and monitoring provisions. For example, the only capacitor-coupled connection through the system of chamber, Log n, Period, Sigma and Magnet amplifiers, and Magnet, is the differentiating capacitor in the Period Amplifier. In discussing circuit or operational failures, not all failures are planned to produce reactor shut-downs, inasmuch as these would interfere with operations. Many failures, however, produce an alarm only, and it is relatively simple to arrange for a desired reactor shut-down in these latter cases if desired.

Summary

It would be misleading to leave the impression that the instrumentation described is typical of AEC installation at present, or that a carbon copy of it would be desirable for future university reactors of all types. The instruments described were developed at the Oak Ridge National Laboratory for specific applications, have been used on other reactors, and are expected to be used on several more reactors in the near future. Improvements are to be expected in most of the instruments, but the basic construction will probably change slowly. Most of the instruments described are now useful; those manufactured each succeeding year should be better from the standpoint of reliability, accuracy, and convenience of use.

Maintenance and Servicing of

ELECTRONIC INSTRUMENTS

First step in assuring the accuracy of test instruments is establishment of a preventive maintenance program. The program for a department with 1100 instruments is presented. This is the first of a series on servicing electronic instruments.

by JAY DOBRIN
Western Scientific Company

ARE you making measurements with a rubber yardstick? Too many manufacturers and maintenance crews are.

Although preventive maintenance has grown to major proportions in business and industry, one phase is frequently overlooked. That phase is preventive maintenance of the measuring devices and instruments used to insure proper functioning of production equipment.

It is not enough to depend on original calibrations when using instruments whose accuracy and reliability affects the quality of manufactured products. The accuracy and reliability of test instruments should be insured by a program of preventive maintenance which is as complete as that for production machinery.

Like other equipment, electronic test equipment does not become inoperative at the same time it becomes inaccurate. Owing to the gradual deterioration of vacuum tubes and other parts, such units have a curve of effective usefulness somewhat like that shown in Fig. 1.

As the instrument ages, and its component parts begin to deteriorate, it begins to become inaccurate. The user does not know that his test instruments are beginning to show error. He may make many measurements, all of which are in error. Eventually, however, the readings or results become improbable or the device ceases to operate. Then the instrument is sent in for repair, depriving the shop or laboratory of the use of the equipment while repairs are under way.

Test instruments maintain the plant standards. In the absence of positive knowledge that his instrument is doing what it is supposed to do, the manufacturer may be either shipping a defective product or rejecting a good product. Only with regularly certified instrumentation can he be sure that the product he manufactures to a certain specification this year is the same as that manufactured to the same specification at any other time.

Such a program of certified instrumentation has been instituted at Lenkurt Electric Co., where the manufacture of high-quality frequency-division carrier systems for the telephone industry calls for a high degree of instrument accuracy.

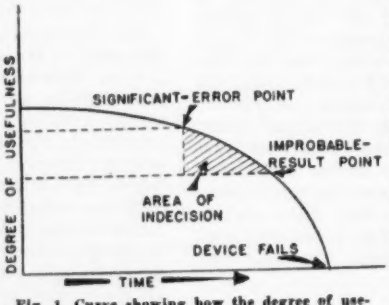

Fig. 1. Curve showing how the degree of usefulness of an electronic test instrument can change with time.

The program described below is that designed for about 1100 instruments. Approximately 140 man-hours per week, including supervision, are required to operate the program.

SETTING UP A MAINTENANCE PROGRAM

The first step in setting up an instrument preventive-maintenance program is to establish adequate records of the equipment to be maintained. Separate records should be kept on each instrument; for this purpose some type of card file is most practical.

Information on each instrument should include: (1) Type of instrument. (2) Manufacturer and model number. (3) Manufacturer's serial number. (4) Company asset number. (In lieu of such a numbering system, assign a service plan number. Confusion will result if an attempt is made to schedule maintenance from the serial number.) (5) Location where the instrument normally is used or kept. (6) Date acquired.

The service history of each instrument is kept on these cards. At each periodic service, and in cases of failure-in-service, an entry is made. This entry includes: (1) Date. (2) Identity by socket number of tubes replaced. (3) Other part replacements. (4) Adjustments. (5) Remarks or complaints from user.

A schedule should be prepared to insure that each instrument is serviced at proper intervals and is not omitted from the preventive maintenance routine.

As different types of instruments may require service at intervals of three months, six months, or a year, equipment should be placed in groups for maintenance servicing. A color code added to the service history card will simplify this problem. For example, all instruments due for service quarterly in January, April, July, and October might be placed in a red code; all instruments due for service quarterly in February, May, August, and November in an orange code; etc.

In beginning the program, care should be taken to divide the service load; all or most of any one type of instrument should be on one schedule; for

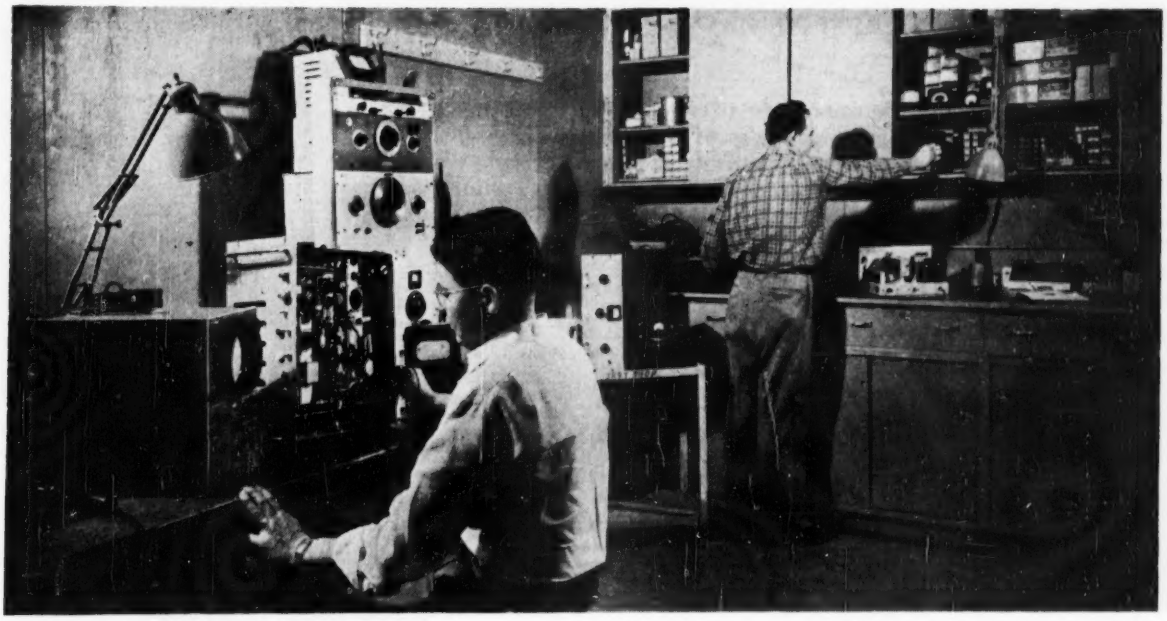

Fig. 2. Instrument maintenance shop, Lenkurt Electric Co. Shop foreman, Nick Garcia, checks an Events Per Unit Time meter while Royal Metzger obtains supplies from wall cabinet.

example, all vacuum-tube voltmeters should be on one schedule to minimize set-up time.

Parts and supplies for the program should be ordered on the basis of the number of instruments in the program. In the Lenkurt program, tubes are stocked in accordance with the following table.

Quantity Installed	*Stock*
1 to 2	1
3 to 9	3
10 to 15	6
20 to 30	12
over 30	33 percent

Exceptions to this rule will appear, depending on the nature of the equipment. Tubes used in push-pull, for example, should be considered in pairs for inventory purposes. If industrial tube types are used, inventories can be reduced.

Every electrolytic capacitor should be anticipated as a replaceable item, and as such a stock should be kept to provide a number of each type.

Meter parts, such as moving coils, jewels, and pivots should be ordered with the advice of an instrument company representative; it often is more economical to stock entire meters and send defective meters to the factory for repair when required.

Operating the Plan

A number of simple rules should be followed after the program has been launched. A few of these are:

(1) Look for trouble. The fact that an instrument has been in use for one or two years is no assurance that there are no unsoldered connections in it. A tube socket may have been left unsoldered at the factory. Changing a tube or tapping the chassis while looking for another trouble may have dislodged it from contact. Every connection, no matter how long the unit has been in use, should be inspected.

(2) Age each tube before it is installed.

(3) Age the instrument after service, preferably in its operational setup.

(4) Replace tubes whose transconductance is down to 70 percent of rated gm; they must be replaced at 60-percent gm.

(5) Work in a clean place.

(6) Do not attempt recalibration of an instrument against a standard which has less than five times the accuracy of the instrument itself. That is, 5-percent meters should be recalibrated on at least 1-percent equipment.

(7) Prepare and follow a guide for service of each type of instrument to insure that each piece of equipment gets a thorough check before it is returned to use.

Good primary and secondary standards are required for this program; special instruments often are useful. For example, annulling traps for various frequencies are valuable in measuring distortion in the output of oscillators.

Result of Program

Regardless of the nature of the instrumentation, a preventive program for regular calibration and adjustment can be evolved. Manufacturers of instruments are helpful sources for such data. Instrument manufacturers supply excellent material on maintenance of their equipment. By use of a plan of this type, preventive maintenance will guarantee you (1) no down time, (2) safety to expensive parts and components, (3) no erroneous readings, (4) no time wasted in re-taking readings, and (5) assurance that bad products will not be shipped nor good products rejected. The bibliography presents much detailed servicing data. The servicing of vacuum-tube voltmeters, oscilloscopes, and signal generators will be described in succeeding installments, which will cover the instrument components, routine service procedures, check of absolute calibration, check and compensation for frequency response, run-in, final check, symptoms, etc.

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Circuit faults in thermocouple pyrometry often are ignored—perhaps because of the difficulty of checking low-resistance circuits. A new instrument automatically checks the complete circuit and "restores" defective contact points and poor connections.

The Thermocouple Circuit

RESTORER

By ALEX SHERMAN
Sherman Electric Co.

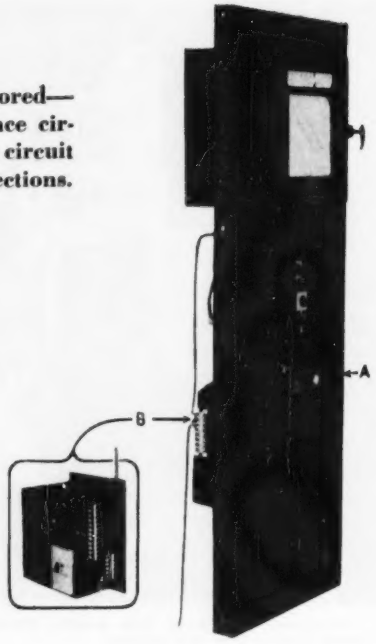


Fig. 1. Panel-mounted model of Restorer. Press-button A operates unit B to check circuit.

POOR CONNECTIONS, corroded joints, oily contacts, and defective thermocouple tips are common causes for errors in the thermoelectric pyrometers, galvanometer circuits, millivoltmeter circuits, etc. These *circuit faults* cause voltage drops so that all the emf. from the thermocouple can not reach the indicator. No matter how accurate the indicating instrument is, a true temperature reading can not be obtained if a high-resistance fault exists anywhere in the circuit between the thermocouple tip and the indicator. This fact has been well established and mentioned often in the literature.[1,2,3,4]

This is true even for electronic-type potentiometer indicators. The reason for this is that although no current flows at balance in potentiometer-type indicators, some current must flow whenever the circuit is not balanced; and whenever current flows, the unwanted emf. drop across corroded or poor connections represents a source of error that is not always appreciated. Whenever the external resistance exceeds a certain value, the indicated temperature will be in error. This is true for all types of indicators, although it takes more resistance to affect the electronic-type indicators than the D'Arsonval type.

Although some troubles can be detected by observing the pyrometer, the trouble may have progressed to a dangerous point by the time that it becomes visible on the chart. To say it another way—between a very good and very bad indication there exists an in-between condition that is neither very good nor very bad, but which can offset quality control and do much damage.

When temperature is used as a basis for control, accurate readings are doubly important because the inaccuracy causes corrective action that can be doubly dangerous. As the circuit fault generally causes a reading that is too low, the controller automatically raises the temperature to a value that is too high—often with disastrous consequences. For example, if the indicated reading is 50 degrees too low, the controller automatically raises the temperature until it coincides with the desired control point—which then is 50 degrees too high. It is obvious that it is as important to assure oneself regarding the correctness of the circuit as it is regarding the correctness of the pyrometer.

Restorer Principle

The Restorer* is a device developed for the purpose of quickly checking and "restoring" low-resistance electric circuits. When the pushbutton on the Restorer is pressed (Figs. 1 and 2) a special electrical pulse is sent through the circuit to be checked. The pulse fuses together all poor connections, loose twists, and oxided joints, and re-establishes good contact. This is the principle of operation of the Restorer.

The Restorer does the following:

(1) Checks the circuit. If the reading changes after the Restorer is operated, one knows that trouble exists in the line—and that the trouble has been corrected temporarily.

(2) Prevents catastrophic mistakes. As the temperature indication after use of the Restorer is the true reading, and as the restored circuit will remain correct for minutes to many hours, the operator can complete his heat or heat treatment or unit process operation.

(3) Eliminates rejects and reclassifications or reheat-treats.

*Patent pending.

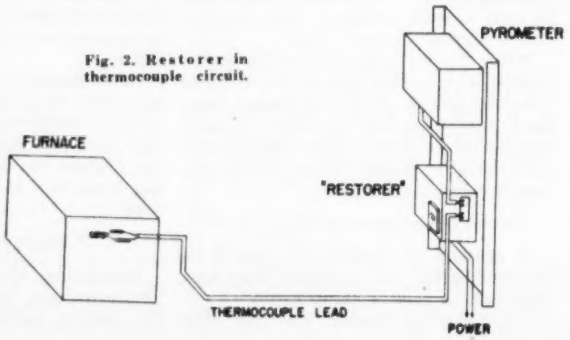


Fig. 2. Restorer in thermocouple circuit.

Presented at the third conference on Instrumen. tion for the Iron & Steel Industry, Pittsburgh, March 26-27, 1953.

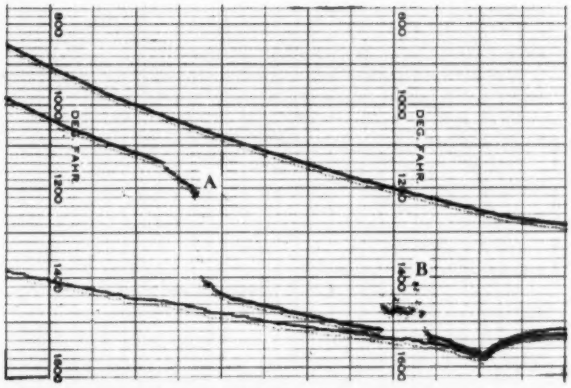


Fig. 3. Heat-treating operation in which three thermocouples are used in furnace. Use of Restorer at point A reveals one thermocouple to be reading too low by about 180 degrees. Second use of Restorer at point B was necessary to complete heat treatment properly.

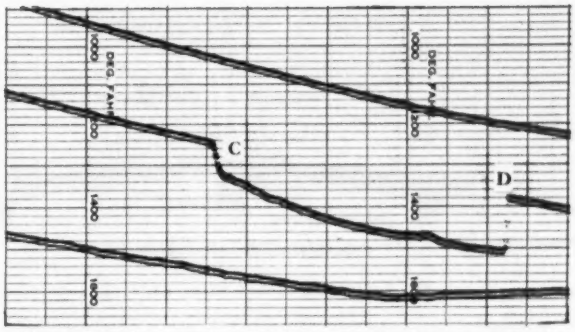


Fig. 4. Example of operation in which thermocouple began reading too high because of tip deterioration. Use of Restorer at point D enabled heat treatment to be concluded accurately.

(4) Saves equipment. Overheating of furnaces reduces the life of the furnace lining. Steel in furnaces and ladles has gone through the bottom because of overheating.

(5) Saves material. If steel is tapped at too high a temperature the yield decreases and stickers result. Also, skull results from too low a temperature.

(6) Saves time. By preventing the development of excessive temperatures, time need not be lost while waiting for the temperature to drop.

(7) Increases quality. When steel is heated and quenched, too high a temperature causes brittleness; too low a temperature causes softness. Saltbath furnaces, galvanizing tanks, smelting furnaces, and bell or box-type annealing furnaces should be operated at the proper temperature for quality results.

(8) Eliminates indecision. When two thermocouples are used to check the temperatures of furnaces, and when the readings do not agree, the question arises as to which is the true reading. A Restorer can eliminate the doubt. Some of the extra thermocouples now being used to check other thermocouples can be eliminated by use of a Restorer.

(9) Saves fuel and electricity. By eliminating overheating, savings can be realized in fuel costs.

Use of Restorer

The Restorer is simple to operate. It is installed in series with the thermocouple and indicator, as shown in Fig. 2. The pushbutton station "A" (Fig. 1) is the only part that need be exposed. A white light indicates that power is on; a red light indicates that the circuit has continuity and that the Restorer is in use. A pushbutton is added for each circuit to be checked.

The lights are necessary to check the operation. The white light assures that the instrument is energized; the red indicates that it has been operated. To operate the Restorer, the operator merely presses the button for the circuit to be checked and then observes the reading on the pyrometer.

Figs. 3 and 4 show actual results obtained with a Restorer installation on a heat-treating furnace equipped with three thermocouples and an L&N "Speedomax" recorder. Fig 3 shows a typical record in which the three couples are apparently reading properly. At point A the Restorer was used to check all three readings. The middle trace was revealed to be in error by about 180 degrees. Note that the "restored" circuit operated properly until some time later, when the circuit defect again caused trouble. Another use of the Restorer (at point B) corrected the circuit and permitted the heat treatment to be finished properly. Of course the circuit defect was permanently corrected at the conclusion of the operation.

Fig. 4 shows another record in which one thermocouple began reading too high (at point C) because the thermocouple tip was attacked. The Restorer was used at point D, correcting the difficulty for the remainder of the operation. Note that the circuit restoration remains for minutes or hours after use of the Restorer.

The Restorer is available as surface-mounted model, panel-type model, and also as an automatic type. The automatic type can be used anywhere, but is especially recommended for immersion thermocouples for electric-arc furnaces, open-hearth furnaces, induction furnaces, etc. This is because immersion thermocouples usually have one or more plug-type connectors and screw-type connections that are common sources of poor contact. As little time can be spent in the actual temperature measurement, it is necessary to have automatic operation of the Restorer. The automatic model of the Restorer automatically turns itself on and then off. During the "on" period, all connections—plug contacts, twisted connections, thermocouple tip, etc.—are restored by the pulse.

Another model is available to check for penetration. Plants using thermocouples to measure liquid metals—such as zinc, tin, aluminum, or liquid salt—usually protect the couples by means of special protection tubes. However, protection tubes may be attacked by the surrounding metals or salts, and pin holes may cause infiltration of the surrounding material. When metal or salt enters the tube it starts to shorten the thermocouple and alters the thermocouple junction; a temperature much different than that existing at the tip will be indicated. Errors of as much as 200 deg. have been caused in this way. If the solution surrounding the protection tube eventually rises in the tube to its own level, a new thermocouple will form at the level of the solution, where the temperature is lower. In the event that the pyrometer has an automatic shut-off feature, a whole process can be shut-off because of these difficulties.

The Restorer can be used with any type of thermocouple: iron-constantan, chromel-alumel, or the various platinum wires. It can be used on any gauge thermocouple wire, from the very thin gauge to the very heavy gauge, and it can be used with any length of extension lead wire.

To summarize: The Restorer is no memory device. It does not require a new pyrometer; it does not shut off the heat. It detects and restores poor or loose or oxidized connections anywhere in the thermocouple circuit, and actual cracks or breaks in the couple line. These errors are indicated and temporarily repaired. Therefore, the temperature processes and the heat-treating processes are as closely controlled as possible, and have the maximum accuracy obtainable. This saves time, fuel, equipment, and labor, and maintains the highest quality of product—the achievement that all instrument men strive for.

References

1. C. H. Cambell, "Modern Pyrometry," page 126.

2. G. K. Burgess and H. LeChatelier, "The Measurement of High Temperatures," page 148.

3. D. J. Pearse, *Industrial Heating*, November 1952, "Thermocouple Maintenance," page 2064.

4. M. F. Behar, "Handbook of Measurement and Control," page 113.

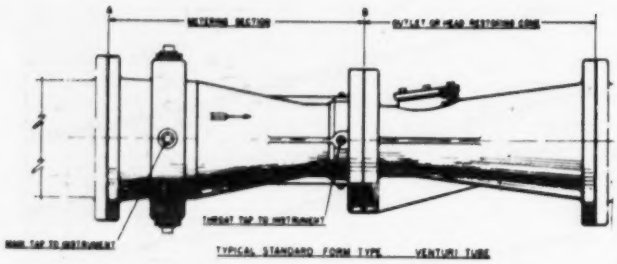

METERING SECTION
OUTLET OR HEAD RESTORING CONE
THROAT TAP TO INSTRUMENT
MAIN TAP TO INSTRUMENT
TYPICAL STANDARD FORM TYPE VENTURI TUBE

Fig. 1. Standard Venturi "Type VT."

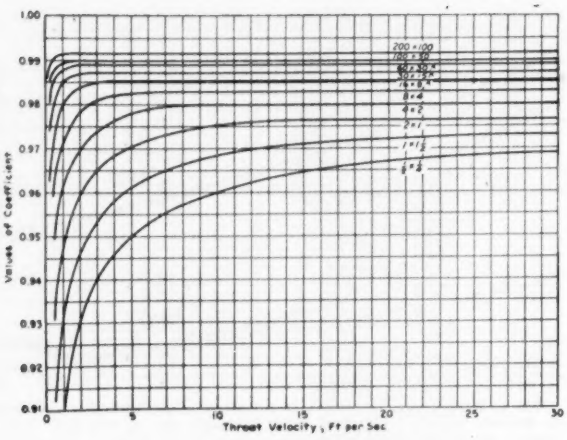


Fig. 2. Venturi coefficients.

Special-purpose Venturi Tubes

Special-purpose Venturi tubes include insert types and those with sheet-steel cones, concrete cones, cleaning valve, eccentric tubes, and elliptical tubes.

by F. L. SOMMER
Simplex Valve & Meter Company

VENTURI TUBES are differential-pressure-producing devices for installation in pipelines (Fig. 1). They provide a dependable relation of differential pressure to velocity and return from 80 to 85 percent of the velocity head developed for meter operation. Of extreme importance is the high accuracy and stability of their coefficients, which makes possible high accuracy of flow measurement. Fig. 2 shows coefficients established by test, and which partially formed the basis for the 1944 A.S.M.E. Standards.

Standard Venturi tubes are constructed with pressure belts at the main and throat sections, connected to the interior surfaces of the tubes by a series of carefully drilled holes presenting clean, sharp corners at the point of entry at the inner surface. The converging upstream and diverging recovery sections are bolted together at the throat section, and a bronze throat-liner usually is provided at the throat section.

Fig. 1 shows the standard Venturi "Type VT," normally used for the measurement of water; it can be utilized also for air or gas flows. The main and throat sections are circular and concentric, with both the top and invert of the tube inclined. Pressure belts are integrally cast at both the main and throat. The main taps are bronze bushed; at the throat they are drilled through the bronze liner. The terminology is shown.

A minor variation of the standard cold-water-type tube has a sheet-steel or steel-plate outlet cone. At times both the measuring (entrance) cone and the outlet cone are constructed of sheet steel, with the throat consisting of a separate cast-metal flanged section between the cones. Plain ends are often furnished for welding in the steel pipeline; Dresser-coupling-type ends also can be provided. For economy, a steel-plate tube is often used for large units of over 20-inch diameter.

Presented at Conference on Instrumentation In Water Sewage and Industrial Waste Treatment, May 14, 1953, Manhattan College, N. Y.

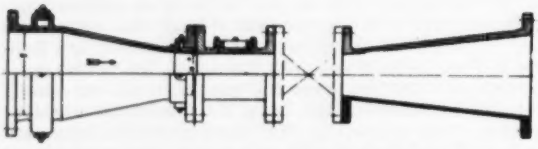


Fig. 3. All-cast-metal measuring section with provision for insertion of a throttling valve; cast or sheet-metal outlet cone.

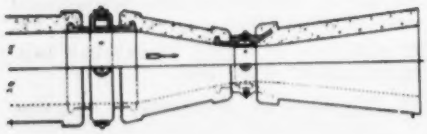


Fig. 4. Cast-metal main barrel and bronze-lined-throat Venturi with cones formed in concrete.

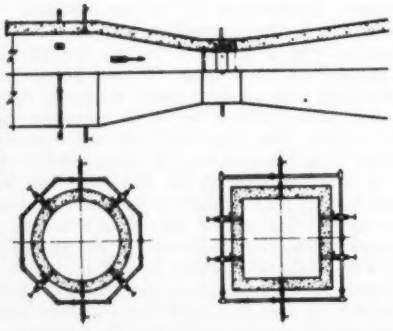


Fig. 5. Circular or rectangular main and throat Venturi formed of pads and pipe belt with cast-metal bronze-lined throat all incased in concrete.

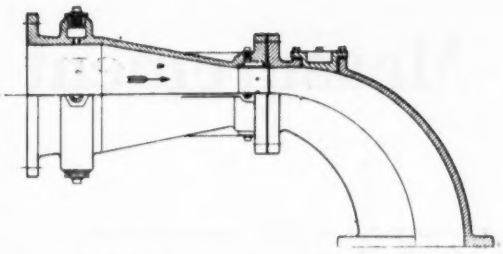


Fig. 6. Cast-metal measuring-section Venturi with outlet cone formed by an enlarging elbow.

Often it is desirable to use the reduced diameter at the throat section to install a valve for shut-off or throttling purposes. By use of a smaller valve, considerable saving can be effected, particularly where the main size is large. Fig. 3 shows the spool piece downstream of the throat, separating it from the valve to avoid any effects of valve throttling on measurements being taken at the throat. The valve is not shown, but the downstream cone can be seen.

In Fig. 4, the converging and diverging inlet and outlet cones are of concrete. Many variations of this tube are made. A cast-iron main and throat piece is illustrated, with the throat having a bronze lining. The castings are imbedded in the concrete.

Another version of the concrete tube (Fig. 4) has a series of bronze piezometer pads imbedded in concrete around the main section for averaging purposes, with the pads interconnected by a pipe belt. The throat is a cast-metal piece with a bronze lining. Note that both circular and rectangular forms are shown.

Fig. 6 is another variation of a standard tube employed where piping length is restricted and all upstream straight run must be used for optimum accuracy. This represents an impossible installation for an orifice plate, which requires straight downstream pipeline.

Where high pressures exist, it often is desirable to place the tube wholly within the interior of the pipeline. The "Type TG" insert Venturi tube has a mounting flange to be installed between two of the pipeline flanges. Fig. 7 shows another insert tube, which is installed by use of a Dresser coupling.

The tubes shown thus far are designed primarily for flow of water, although they are used for air or gas. Fig. 8 shows a special form designed for installation in a large, square, concrete duct for air flow. To reduce length, the upstream cone follows the TG curve in one plane only. The invert and top are flat so that the throat reduces to a rectangle, then again flares back to the square shape. The recovery cone is concrete.

Fig. 9 shows the "Type VS" for sewage measurement. It is essentially a standard cold-water tube with four cleaning valves at the main and throat for occasional reaming of the piezometer openings. These are usually hand-operated, but can be powered by air or hydraulic pressures. Holes with removable covers are added at the main and throat belts to aid in cleaning the belts when necessary.

Another unit designed for sludge service has a single tap at the main and throat, each equipped with a bayonet-type cleaning valve. No belts are used, thus eliminating clogging at these points; however, no pressure averaging can be obtained.

The eccentric tube (Fig. 10), for measurement of sewage with a minimum of maintenance, has a flat invert to avoid entrapment of sediment ahead of the throat. Air release valves often are employed at the main belt to permit the exit of gases which might tend to collect at the high point.

Fig. 11 shows the furthest advance in ease of sewage measurement—the elliptical type, having both a flat invert and top. Pressure averages are obtainable by pipe manifolding. Cleaning valves are included at each tap. If continuous backpurging with a small amount of plant water supply is used, practically no maintenance is required.

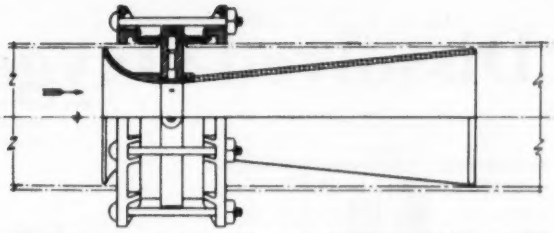


Fig. 7. Venturi similar to "TG-1" for installation within a Dresser coupling.

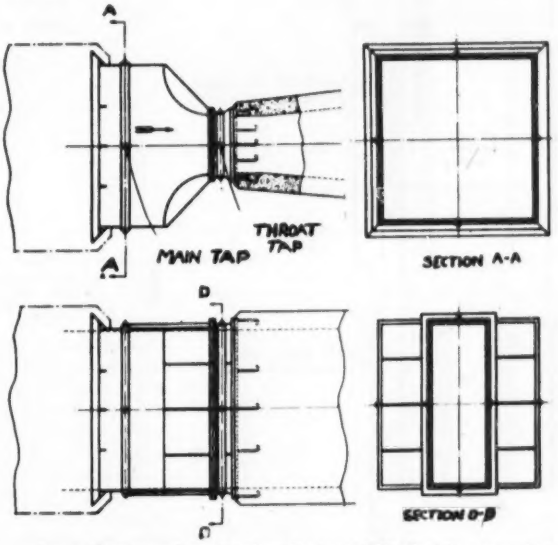


Fig. 8. Square and rectangular sheet-metal Venturi for concrete conduit to measure air flow.

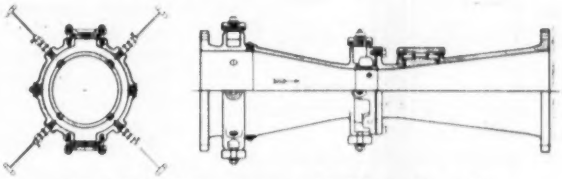


Fig. 9. Venturi for sewage or liquids carrying solids.

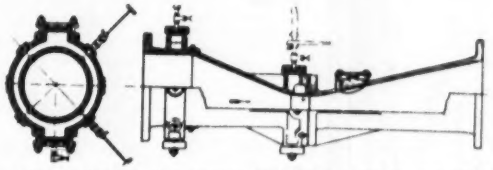


Fig. 10. Venturi for sewage or liquids carrying suspended matter.

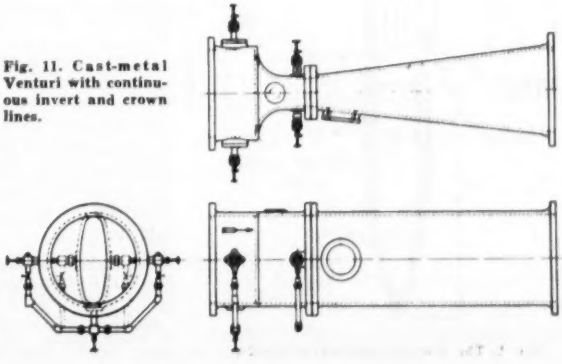


Fig. 11. Cast-metal Venturi with continuous invert and crown lines.

Dissolved-Oxygen Measurement

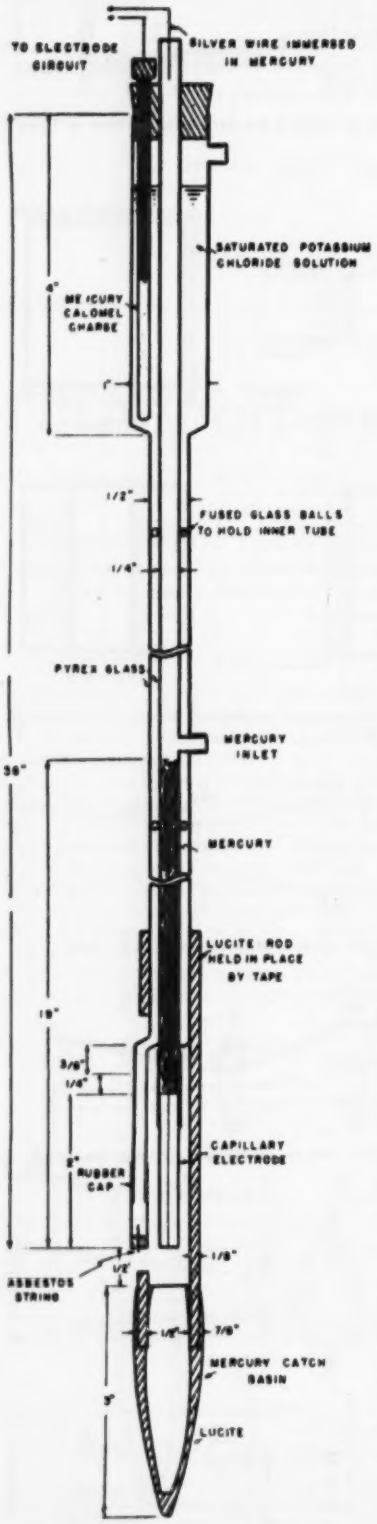


Fig. 1. The dropping-mercury electrode.

Continuous measurement of D.O. concentrations are possible with either the dropping-mercury electrode or the rotating platinum electrode. Construction and use of the two electrodes are presented.

By A. T. IPPEN and C. E. CARVER, JR.
Massachusetts Institute of Technology

U. S. Public Health Service* sponsors a research program at the M.I.T. Hydrodynamics Laboratory on solution of oxygen from the air supplied to activated-sludge process for sewage and industrial waste treatment. Experiments were performed on the aeration of clear tap water in a lucite column, two to twelve feet in height, at the bottom of which air bubbles were uniformly dispersed at a known rate and bubble size. Dissolved-oxygen concentrations (from about 0.20 ppm. to saturation concentrations) were continuously recorded by means of a dropping-mercury and a rotating platinum electrode in combination with recording milliammeters. Winkler tests also were employed to check the performance of these instruments.

The Dropping-Mercury Electrode

The dropping-mercury electrode (Fig. 1) consists of two concentric Pyrex glass tubes with an over-all cross-section of 0.5 inch in diameter. The inner tube feeds the mercury to the capillary electrode through a short length of plastic tubing. The outer tube, which constitutes the anode, is essentially a calomel half-cell. It is filled with saturated potassium-chloride solution at the top in a sealed tube. A short length of asbestos cord inserted through a rubber cap located near the capillary completes the electrical circuit.

The length of the unit is 3 feet. Spot oxygen-concentration measurements can be made to a depth up to 30 inches and more. Its streamlined design causes a minimum of interference with the free flow of air bubbles. A streamlined cup machined from lucite catches the mercury droplets ½ inch below the capillary.

* Investigation supported by research grant RG-863(C4) from the National Institute of Health, Public Health Service.

Presented at Conference on Instrumentation in Water Sewage and Industrial Waste Treatment, May 14, 1953, Manhattan College, N. Y.

Mercury can be fed to the capillary through a side opening connected to a mercury reservoir or manually at the top. Introduction of 1 ml. of mercury through a pipette every hour keeps the mercury head above the capillary at 19 ± 0.5 inches. This results in a mercury droplet every 2 seconds at the capillary, which consists of marine barometer tubing with a bore of 0.03 mm.

The apparatus consists of four components—the electrodes, the electrode circuit, the amplifier, and the recorder. The electrode circuit transforms the greatly fluctuating current from the electrodes to a mildly fluctuating voltage, which then is amplified by a d-c. amplifier to drive the recorder (Esterline-Angus "Model AW" graphic recorder with full-swing deflection of 1 milliampere).

Operating Characteristics

Reduction of dissolved oxygen in water at the dropping-mercury electrode is characterized by two distinct waves, as shown in the polarograph of Fig. 2. The first wave has a pronounced maximum at 0.5 to 0.8 volt. As aeration experiments were carried out in clear tap water relatively free of foreign matter, the flat portion of the second wave was used and an operating potential of 1.8 volts was selected. Residual current at zero dissolved-oxygen concentration may be compensated for in the calibration.

Temperature vs. current curves show that current varies linearly with temperature. The temperature effect on the current is more pronounced at higher D.O. concentrations.

The calibration curve for the oxygen meter is shown in Fig. 3, from which dissolved-oxygen concentration can be obtained for various temperatures as a function of a microammeter reading. These curves were obtained before the graphic recorder was incorporated. A new set of calibration curves was developed for use with the recorder. A

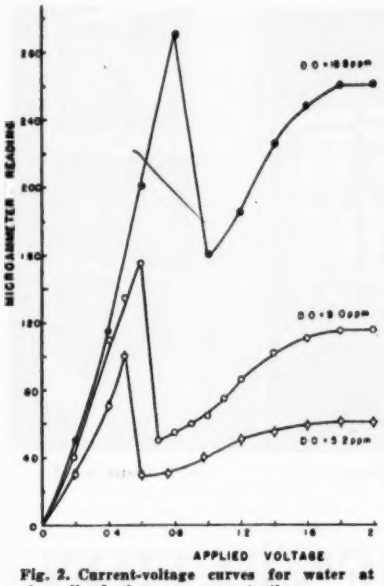


Fig. 2. Current-voltage curves for water at various dissolved-oxygen concentrations.

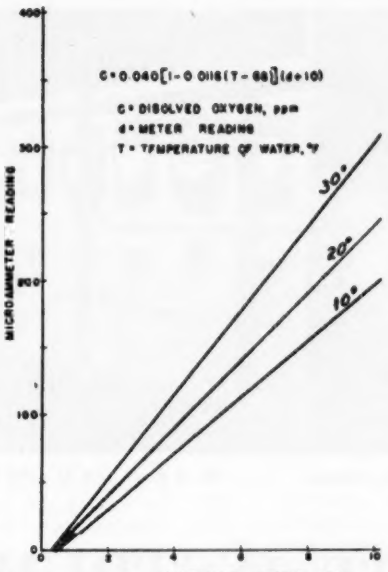


Fig. 3. Calibration curves of the oxygen meter.

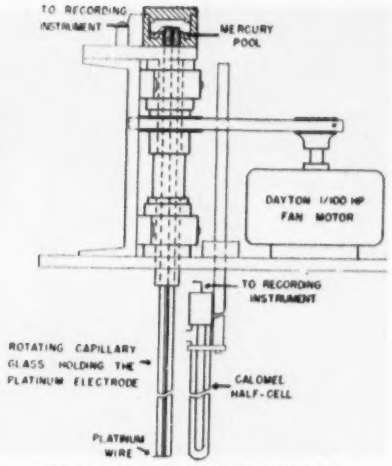


Fig. 4. The rotating platinum electrode.

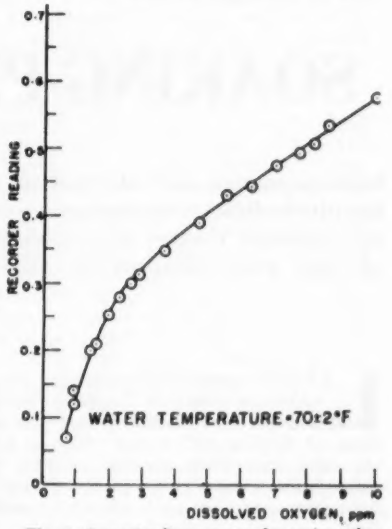


Fig. 5. Current-voltage curves for water using the platinum electrode.

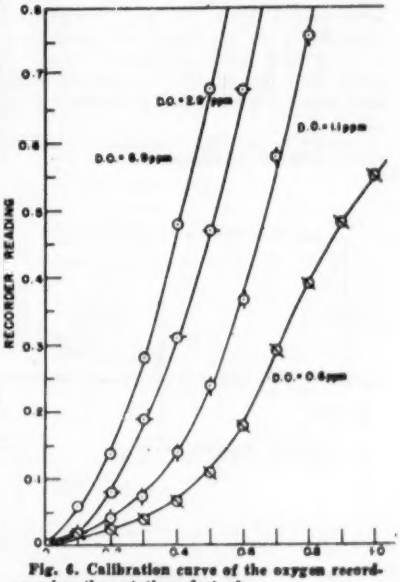


Fig. 6. Calibration curve of the oxygen recorder using the rotating electrode.

"high-low" scale switch was installed in the recorder circuit whereby full-scale deflections could be obtained in the ranges 0-3 and 0-15 ppm.

Rotating Platinum Electrode

The rotating platinum electrode is shown in Fig. 4. A platinum wire of 0.5-mm. diameter is inserted into a glass tube with an I.D. of 2 mm. The wire is held by sealing wax and is bent normal to the axis of rotation of the glass. The exposed surface of the wire is covered with wax except for the 3 mm. protruding length, which always is kept polished.

The glass tube is mounted in a steel shaft, allowing use of any length of tubing. The steel shaft rotates in bronze bearings and is belt-driven from a motor. The shaft itself rotates at 850 rpm. within ± 0.5 percent. A calomel half-cell mounted on an adjustable lucite rod holds the tip of the cell within half an inch of the wire tip.

The top end of the glass tube rotates within a piece of lucite which has a mercury reservoir. The free end of the platinum wire extending from the end of the glass tube is bent down and rotates immersed in the mercury in this reservoir. A stationary wire loop completely submerged in the mercury but not touching the platinum wire is connected to a pick-up point outside this reservoir and thus completes the electrical circuit.

The basic equipment required to record dissolved oxygen in water by means of the rotating platinum electrode is identical to that required for the dropping-mercury system, except for the electrode unit.

Operating Characteristics

Current-voltage curves for the electrode are shown in Fig. 5. Operating potential has a tremendous effect on the current produced, particularly at higher concentrations. The measuring range of the instrument was not sufficient to obtain the complete polarogram; accordingly, a potential of 0.4 volt was chosen for calibration purposes. The calibration curve is shown in Fig. 6. Unlike the curves obtained with the dropping-mercury electrode, the platinum electrode does not give a straight line. It holds only for temperatures between 68 and 72 deg. F.

Results

Dissolved-oxygen concentrations were measured in a 5.5-inch I.D. lucite column initially containing clear deaerated tap water at depths varying from 2 to 12 feet. Air bubbles ranging in size from 1.25 to 2.5 mm. were dispersed uniformly at the base of the column through a specially designed nozzle. The air supply was accurately metered by rotameters; tests were terminated at saturation concentration.

Typical oxygenation curves using the mercury-dropping electrode indicate the agreement with D.O. concentrations as obtained by the Winkler method. The rotating platinum electrode has not been extensively used.

The dropping-mercury electrode should prove valuable where rapid determination or control of D.O. concentration is important. Aside from the fact that it requires frequent cleaning or replacement of the capillary to prevent irregularities in the drop rate, experience has brought forth two handicaps: (1) Damping is required to reduce the fluctuations of the recording trace due to the unsteady signal from the electrode; this damping is accomplished at the expense of sensitivity; above 3 ppm. the trace appears as a "band" rather than as a fine line. (2) The most serious drawback is that the instrument is limited to conditions where turbulence is a minimum. Dis-

(*Continued on page* 143)

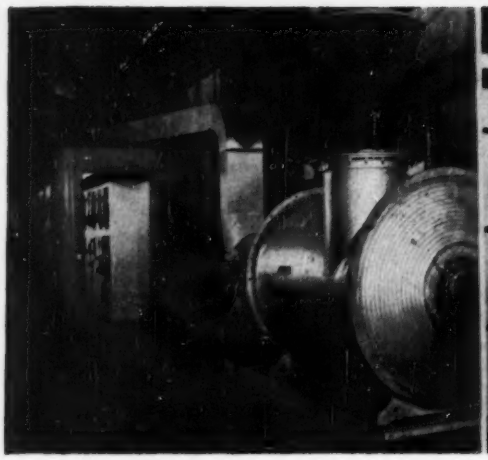


Fig. 1. Control house for one bank of four pits, showing blower for pressurizing the house.

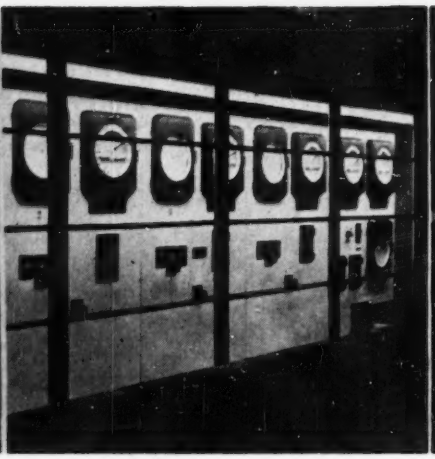


Fig. 2. Front view of panel board.

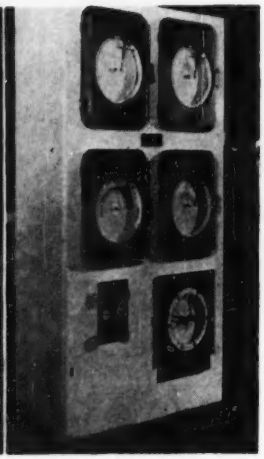


Fig. 3. Master panel.

SOAKING-PIT INSTRUMENTATION

Instrumentation and combustion control for large one-way-fired soaking pits includes temperature control of recuperator air and combustion air, pressure control of combustion air and flue draft, flow control of fuel and combustion air, and various safety interlocks.

By L. F. KOPSA
Jones & Laughlin Steel Corp.

LATEST installation of soaking pits at the Pittsburgh works of Jones & Laughlin Steel Corporation consists of three banks of four pits each, having dimensions of 27'0" x 9'6" x 14'0" with a depth of 12'6" above the coke line. They are the longest, if not the largest, single-burner one-way-fired pits in this country. They are fired with coke-oven gas; #6 oil is available as a stand-by fuel.

The minimum amount of instruments and combustion controls were selected which would render satisfactory performance with the least maintenance. As divided responsibility in servicing this equipment is not conducive to continued good operations, every effort was made to select and install the combusion equipment so that the instrument maintenance personnel could be responsible for its performance with minimum dependence on other service departments.

To insure safety within the control house, all fuel-flow and pressure impulses are transmitted by pneumatic or electric signals for both measurement and control functions, thus eliminating the necessity for the use of carbon monoxide, combustible alarms, and fire-smothering systems used in previous installations.

Fig. 1 shows a control house for one bank of four pits, one of three combustion air blowers, and the blower which pressurizes the control house through ceiling ducts to keep dust infiltration to a minimum.

Fig. 2 shows a front view of the panel board, on which are mounted all combustion-control instruments that can readily be observed. The operators can adjust the control settings.

The panel board consists of five sections, one of which is common for all pits in each bank. Mounted on the board

Presented at the 1953 Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, Pa.

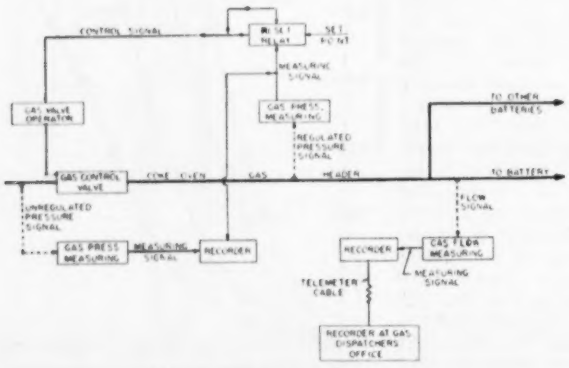


Fig. 4. Gas supply system.

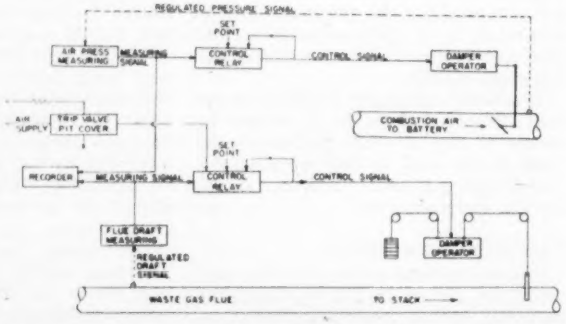


Fig. 5. Combustion-air pressure and draft control for one bank of pits.

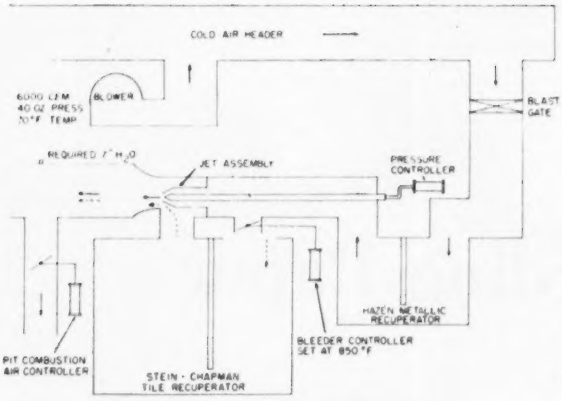


Fig. 6. Combustion-air supply system.

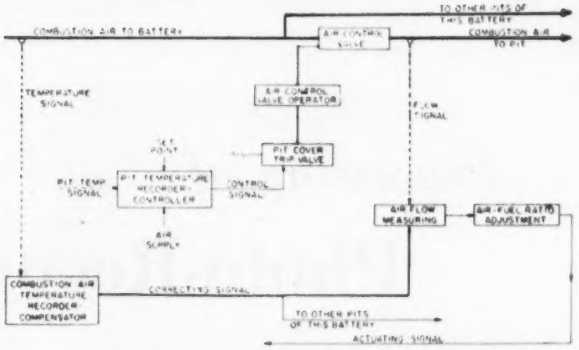


Fig. 9. Pit-temperature control arrangement.

are a metallic-recuperator air-temperature recorder-controller, combustion-air temperature recorder and compensator, combustion-air pressure and flue draft recorder, and transfer panels for automatic-manual operation. The remaining four sections, one for each pit, have a pit-temperature recorder-controller, fuel-flow recorder, gas-oil transfer valve, transfer panel for automatic-manual operation, and ratio relay panel.

Fig. 3 shows the master panel, on which are mounted a total-fuel-flow recorder for each bank, main-line and regulated gas-pressure recorder, fuel-oil temperature recorder-controller, and a transfer panel for automatic-manual gas-pressure regulation. This panel will be enclosed in a control house similar to that of the individual bank shown in Fig. 2.

The temperature recorder-controllers incorporate an electronic measuring unit and a pneumatic controlling unit. Electrical signals are translated to corresponding air pressures through a pilot valve in the pneumatic control system, which operates from 0 to 20 psi. A pointer traveling over a large scale indicates the temperature, which can be read easily without entering the control house. A knob on the outside of the instrument case provides a means of adjusting the desired control point.

In all flow and pressure recorders, the pneumatic signals from the measuring units are imposed on bellows which transmit a movement to the pen arm assembly, which produces a chart record of the existing flow, pressure, or draft conditions; fuel-flow recorders have integrators which register fuel consumption.

Recorders are all of the 24-hour circular-chart type. The charts are changed daily and are available for examination by the operating and combustion personnel. They are then filed for future reference.

The valve operators in the control system are pneumatic cylinders that operate on compressed air supplied from the general plant system.

Fig. 4 shows the *gas supply system* which maintains a predetermined gas pressure in the main header for all pits, and which measures the total gas flow for one bank of pits. The regulated gas pressure measuring unit receives a gas pressure impulse from the main gas-supply line and transmits a pneumatic signal to the reset relay, then to the gas valve operator, which positions the gas control valve in the coke-oven-gas header. The regulated and unregulated gas-pressures are both recorded on one chart, with the unregulated pressure being used as a guide when gas-pressure difficulties are encountered.

The gas flow measuring unit receives an impulse from the orifice in the gas header to each bank of pits and transmits a pneumatic signal to the flow recorder. A telemetering transmitter in the recorder sends an electrical signal to a receiver which records and integrates gas flow. This receiver is on a panel at the Gas Dispatcher's desk.

Fig. 5 shows the *combustion air pressure and draft control* for one bank of pits. A pressure impulse is received from the combustion-air header by the air-pressure measuring unit, which sends a measuring signal to the control relay; in turn, a control signal is transmitted to the damper operator, which positions a valve used to maintain a constant pressure in the combustion-air header.

The impulse received by the flue-draft measuring unit is sent to a control relay, which imposes a control signal on the damper operator used to position the damper in the main waste-gas flue. The air-pressure and flue-draft measuring signals are transmitted to an instrument which records both on one chart. A trip-valve pit-cover relay in this control circuit operates to position the damper, thus maintaining a predetermined draft when a pit is opened.

Fig. 6 illustrates the *combustion-air supply system*, of which there are three, one for each bank of pits. This system consists of an electric-motor-driven blower supplying air through a header that can be made common to all three banks of pits or dampered so as to supply air to individual banks. In our operations, three blowers are used to maintain the desired air-header pressure. The air from the blowers passes through a metallic recuperator where it is preheated, then to a jet assembly where it is controlled to inspirate the

(*Continued on page* 141)

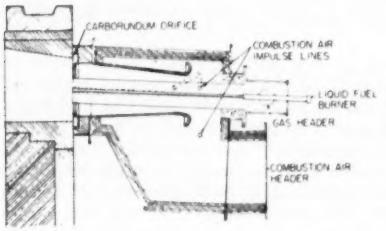


Fig. 7. Venturi tube in pit air header measures combustion air to each pit.

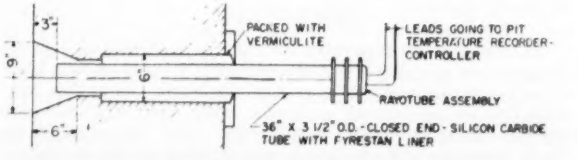

3"
9"
6"
PACKED WITH VERMICULITE
LEADS GOING TO PIT TEMPERATURE RECORDER-CONTROLLER
RAYOTUBE ASSEMBLY
36" X 3 1/2" O.D. - CLOSED END - SILICON CARBIDE TUBE WITH FYRESTAN LINER

Fig. 8. Details of primary element for pit temperature.

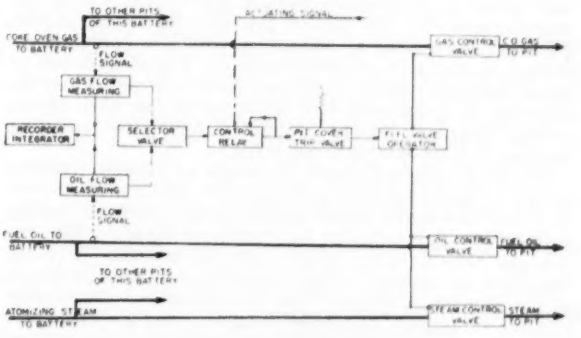


Fig. 10. Fuel-control system.

Processing of
Photo-Recording Paper

Signals on oscillographic photo-recording paper represent a large investment in time, equipment, and money. Five simple and basic steps assure proper processing of the photographic paper.

By H. F. HIEATT
The Haloid Co.

OSCILLOGRAPHY with photographic paper is a basic measurement technique. The measurement obtained may be on a piece of photo-recording paper that costs only a few cents, but many thousands of dollars in equipment and personnel expense usually are invested in the record. For example, a survey by seismic-reflection method requires a large investment, and the decisions made on the results involve huge sums of money. Thus great care should be exercised in processing these records to get the most legible records possible, and to get records that will not stain within months or years. This is made easier by the general improvement in all recording paper in the past few years.

The Emulsion

Any photographic emulsion is composed of a suspension of *silver halides* in gelatine. These halides may be a combination of silver bromide, silver chloride, or silver iodide. The liquid suspension is coated upon either film, paper, or plates, and the resulting layer of emulsion is then processed and made ready for shipment. When exposed to light, a latent image is formed. This latent image is not visible until the sensitized material has been developed.

Processing the paper requires five steps—development, acid stop, fixing, washing, and drying.

Development

The process of development is simply the reduction of the particles of silver halides by a *developer*. A developer has four main ingredients—reducing agent, alkali, accelerator, and preservative. The best proportions of the four ingredients of a developer usually are worked out by the manufacturer for his various products. For most papers, including those used in seismic recording, a standard developer is available in prepared cans. The convenience of these chemicals makes their use more desirable than attempting to make your own developer in the field. If the mixing directions on the can are followed, the resulting solution will be correct in all respects.

Reduction is accomplished by means of organic reducing agents (usually metol and hydroquinone) which are dissolved in water and made active by the alkali (such as sodium carbonate) and controlled by potassium bromide. The potassium bromide also reduces the silver-halide particles that were not exposed to light. In order to prevent oxidation of the reducer by oxygen from the water and air, sodium sulphite or sodium bisulphite is added. Sodium carbonate is, therefore, sometimes called the accelerator, and sodium sulphite the preservative.

The developer should be kept as cool as possible under field conditions, and care should be exercised to prevent any of the other solutions used from being carried into the developer because this tends to flatten the contrast in the prints. Laboratory and studio results cannot be demanded of field parties, but comparable results can be obtained with care. The developer should not be overworked; when it begins to slow down and give flat records, it should be discarded. If your instruments give a white record with black lines, you can work the developer longer without replacing, although it does work slower; however, if your records are black with white lines, the developer should be replaced oftener because the contrast becomes less as the developer ages and oxidizes. This must be left to the judgment of the man developing the records; it is his regular duty to see that his chemicals are working properly.

Acid Stop Bath

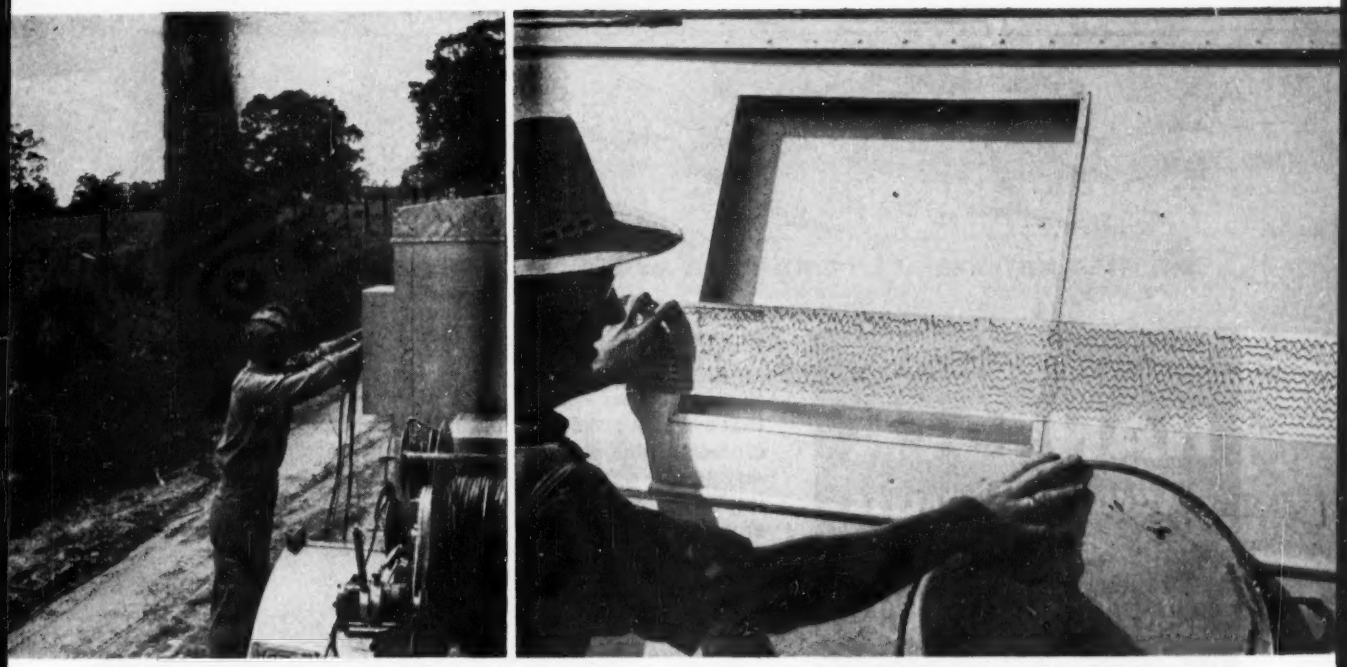
The record is saturated with the alkaline developer after it has been immersed in the developing solution. Therefore, it is advisable to rinse the record in an acid solution, usually a dilute solution of acetic acid. This action is two-fold. First, it neutralizes the alkali of the developer and stops further reduction of the image beyond the point that the operator wishes. Secondly, by neutralization of alkali, it prevents carrying over a considerable amount into the fixing bath, and thereby quickly neutralizing the acidity of the fixing bath. This prolongs the life of the fixing bath. If the use of acid short stop is impossible, a clean-water rinse is better than nothing, but there is little trouble involved in making an acid stop bath.

The usual formula for the acid stop bath is four ounces of 28-percent acetic acid to sixty-four ounces of water. If 28-percent is not available, glacial acetic acid can be bought at most drug stores; use 28 parts of glacial acid to 71 parts of water. This stop bath is an important step in getting clean permanent records and it should be replaced often. When it becomes discolored badly with developer it should be discarded.

Fixing Bath

This is a most important step in the finishing of records because the record permanency depends largely on this step.

After the record has been developed and the action temporarily stopped in the acid stop bath, there still remains on the record the silver halides that were not acted on by light exposure and, therefore, not reduced by the developer. If the record is to be permanent, it is necessary to dissolve



Seismograph Party 17, Humble Oil & Refining Co., sets off charge in vicinity of Huntsville, Texas. Geophones detect reflections from sub-surface strata and transmit signals to truck via cables. Signals are recorded on photo-recording paper by multi-channel oscillograph.

out the unreduced silver halides. This is done by a solution of sodium theosulphite, commonly called hypo. (In order to further harden the emulsions so that they will withstand handling better, alums are often added to the hypo bath, in conjunction with either sodium bisulphite or sodium sulphite and acetic acid.) Like the developer, the complete fixing baths are obtainable in package form; the packages are preferred for convenience and accuracy of measure. For complete benefit of the fixing bath, most manufacturers recommend that the record be left in the fixing bath for ten or fifteen minutes. While in this bath the records should be moved around occasionally; stains can occur if the record is placed in the bath without stirring.

Washing Records

This is another all-important step in obtaining good records. The hypo of the fixing bath forms a double complex salt with the silver halides of the emulsion. Some of the double salt is dissolved out in the hypo, and part remains in the sensitized material. Therefore, it is necessary to wash the record in water for a length of time sufficient to dissolve out this double salt. Incomplete washing results in stains, due to decomposition of traces of this double salt to silver sulphide, giving various shades of yellow and brown.

Drying Records

This sometimes presents a problem in recording work—particularly in wet weather. As most drying machines are not portable enough for field work, the records are hung on the sides of the recording truck, or on lines, or thrown across a wire fence or bushes. In wet or damp weather they will not dry. Some parties roll up wet records in a single roll at the end of the day. This is a bad practice. If there has been faulty processing, which is often the case, there are chemicals left in the records; by the time they reach the office, these chemicals will fade, bleach or stain the record. To overcome this handicap in wet weather, it is suggested that the field party carry along an extra can of about three-gallon capacity, and keep it full of clean water all day; after the records come out of the regular wash, place them in this clean water for the rest of the day. On reaching the field office, they can be hung on inside lines to dry, care being taken that the records do not overlap one another.

Automatic oscillogram processors recently have become available. For example, the "Model 23-109" processor of Consolidated Engineering Corporation processes and dries oscillographic records on any standard recording papers up to 12 inches wide at speeds exceeding 10 feet per minute. The processor has a 250-foot capacity, loads in subdued light, controls the temperature of solutions and drying drum thermostatically. Another automatic processor, made by Young Testing Machine Company, features daylight loading.

Practical Suggestions

Do not over-work any of the processing chemicals or the wash waters; replace all at frequent intervals. The cost of chemicals is much less than a spoiled record. The nearer you approach accepted photographic procedure, the easier and the better the results.

Some men prefer to paste the label on the record as soon as the observer examines it. This defeats the idea of longer fixing and washing. It is suggested that the record be numbered while the observer is making his preliminary examination of the record; all data should be put on a label which has a corresponding number on the reverse side of the label. When the record is ready for drying it can be squeegeed, and the label then applied.

In mixing chemicals, the tanks should be rinsed well. The rod used for stirring the solutions should be of glass, hard rubber, or bakelite. These materials wash easily. A glass towel bar that can be obtained from any dime store makes an excellent stirring rod. If sticks are used, never use the same stick for developer and fixer. Never roll wet or damp records together, or lay wet or damp records on top of one another. When your hand or glove comes out of the fixer, it should be rinsed well before putting it in the developer again.

There may be some objections to following the procedure outlined because of the extra time required, but considering the value of the record, the small extra time is justified.

Modern photographic papers are built to do the job and can produce records that will last for years. The results depend largely on the man developing the records.

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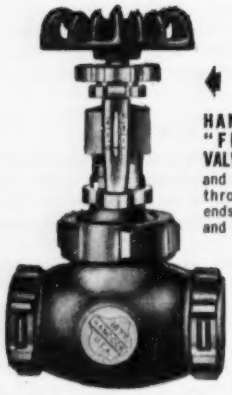

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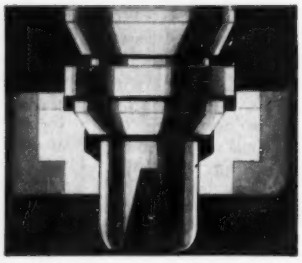

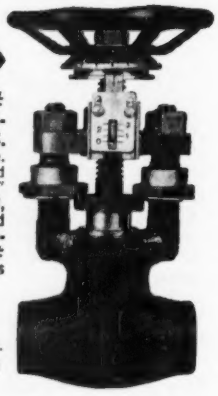

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MODERN INSTRUMENTATION TRENDS

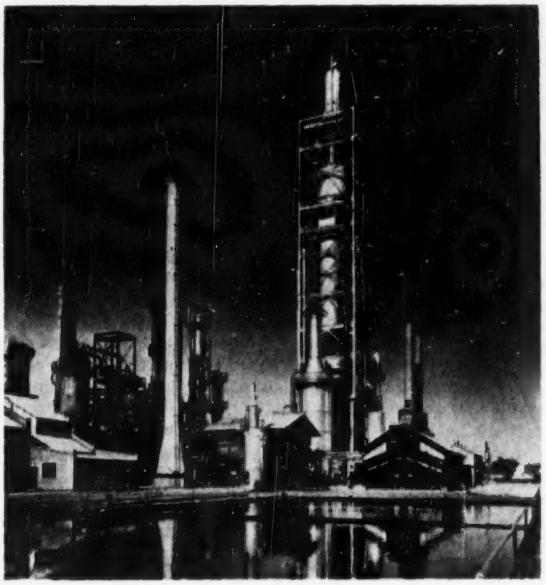

Fig. 1. A modern catalytic cracking unit.

Modern frontiers of instrumentation are (1) analytical instruments, (2) miniature instruments and graphic panels, (3) response speed, (4) computers, and (5) nucleonic instruments. Typical examples of advanced applications illustrate the work underway.

by GLEN G. GALLAGHER
The Fluor Corporation, Ltd.

YESTERDAY'S TOOLS are no longer adequate for today's requirements. A quick resumé of some of the more important trends, in what we feel is their order of relative importance, is:

1. Analytical instruments and controls.
2. More concentrated and more illustrative centralized control with miniature instruments and graphic diagrams.
3. Higher-speed-of-response systems with (a) pneumatic systems using boosters and faster primary pick-ups, and (b) electronic transmission and control.
4. Computers and high-speed data-gathering systems.
5. More use of nuclear instrumentation in the commercial plant.

Analytical Instruments

Concentration controllers use infrared, ultraviolet, vapor-pressure, dielectric, thermal-conductivity and refractive-index methods.

Infrared and ultraviolet spectrophotometers are being used by some oil, chemical and rubber companies for direct fractionating-tower composition control. An important recent improvement is the minimization of interference encountered when one or more of the hydrocarbon components in the sample has an overlapping waveband of absorption with the component being measured. This may be accomplished (Fig. 2) by the use of two infrared beams of light —one passing through the unknown sample and the other passing through a known sample of the undesirable or overlapping constituent. The known sample acts as a filter, which tends to cancel out the interference because of the way it is tied into the measuring circuit.

Another important improvement is in ruggedizing the complete analyzer; laboratory mounting is no longer necessary. The biggest single drawback to this instrument today is probably its cost, which as a recorder-controller

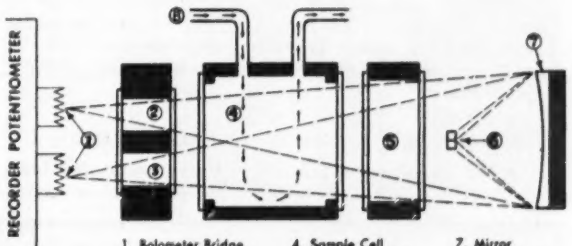

Fig. 2. Infrared analyzer using two beams for interference cancellation.

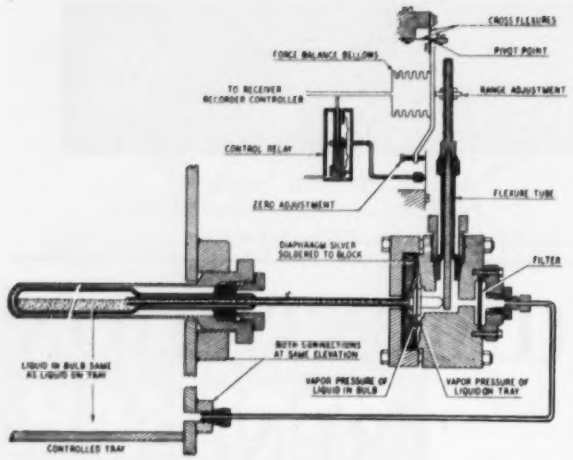

Fig. 3. Differential-vapor-pressure transmitter.

is about $4,600. However, the price will drop when the demand permits higher production methods.

Vapor-pressure differential (Fig. 3) is a relatively simple tool being used successfully in the distilling industry for separation of alcohol from water in whiskey stills. This instrument has been used also in petroleum refineries to separate isobutane from normal butane, and similar applications. It is ideal for strictly binary fractionating towers, where only two components are present. Fig. 4 shows that the deviation in composition which occurred with vapor pressure control was much less than was possible with temperature control when the tower pressure was varied. Although it has limitations on multi-component towers, vapor-pressure control is still considerably better than some straight temperature and pressure methods presently being used. The cost of this unit is little more than a flow recorder controller, and is as simple to operate and maintain. There are many industrial applications for the vapor-pressure-differential instruments that have not been fully explored.

Dielectric-constant capacitance cells have been designed for continuous measurement of dielectric-constant changes in liquid hydrocarbon and miscellaneous refinery process streams. Dielectric-constant instruments have gained favor for recording and controlling chemical and physical process variables. They have been used in measuring water in crude-oil emulsions, and toluene in mixtures with paraffinic and naphthenic type of hydrocarbons. The sample cells can be used with standard capacitance-type recorder-controllers.

Refractive-index methods and the continuous measurement of the refractive index of materials now offer possible solution to many difficult distillation control problems. Separation of Styrene from its parent material by fractionation using conventional temperature control is often unreliable because of close proximity of the boiling points of the parent and product materials. However, as the refractive indexes of the materials are widely separated, control by this means is exceedingly effective. The refractometer can control the reflux rate or the steam to the reboiler.

Miniature Instruments and Graphic Panels

Graphic panels and miniature instruments are being used because plants are becoming so large and so instru-

February Meeting: Saturday, the 13th, Rio Hondo Country Club, Downey, Calif.
Feature: 27th Annual Hi-Jinks.

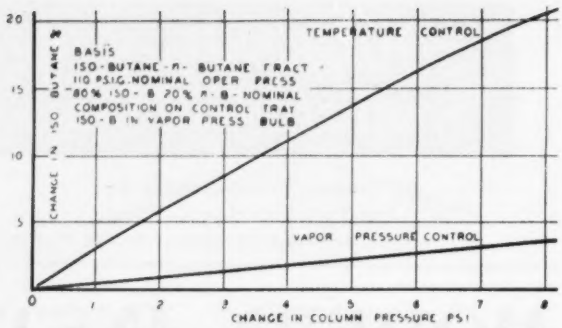

Fig. 4. Composition change on control tray vs. column pressure deviation for binary column using vapor pressure controller or temperature controller.

mented that conventional instrument panels are unreasonably large. Fig. 1 is a modern Catalytic Cracking Unit over twenty stories high. The operator can easily lose his mental picture of the process flow while climbing around this mass of structural steel and piping.

What can be done graphically with the complete refinery processes on one board is illustrated in Fig. 5. From left to right we have a complete Feed Preparation Unit, a Catalytic Cracking Unit and its Fractionation Section, a Gas Concentration Unit, Catalytic Polymerization Unit, and Liquified Petroleum Gas Plant. This almost complete refinery is illustrated graphically in only 29 feet of panel space, whereas by using conventional instruments, mounted two high, about 49 feet of panel would have been required. This makes it possible for operators to keep closer supervision over the many process variables. Other advantages of the graphic type of instrumentation are: (1) easier operator training, (2) minimum personnel, (3) approximately 50 percent less space required (smaller control rooms), (4) higher speed of response when the controller is mounted locally, and (5) lower maintenance due to minimizing of linkages and leverages in favor of the pneumatic force-balance system.

The panel boards are available in two general types—full graphic and semi-graphic. In the semi-graphic panel, the instruments are not located directly in the flow plan, but are banked in groups under and to the side of the diagram and are linked to points of measurement or control in the flow diagram by a colored symbol. In the full graphic (Fig. 6) the instruments are located in the flow diagrams at the specific point where the process variable is being measured or controlled.

Cost Comparison

Graphic panel boards are available in three general types of material—(a) steel board with painted diagram, (b) steel board with ⅛-inch raised anodized-aluminum diagram, and (c) steel or wood board with a plastic Formica covering and diagram.

Here is a price comparison on the various types of graphic panels as compared to conventional instruments mounted two-high on a wired and piped board of ⅛-inch-thick steel on a specific job. The conventional panel was $34,000 complete with instruments; the graphic panel of the Formica type was approximately $1,100, or 3½ percent less; the anodized-aluminum graphic panel on steel was approximately $2,000, or 6.75 percent less; the painted graphic diagrams on steel was $4,000 less, or a savings of 11.7 percent. A major savings is realized, however, due to reduction in size of the control house itself; this space probably cost about $15.00 a square foot.

Plug-in Units

Fig. 7 shows a plug-in-type controller, which can be plugged into the board-mounted instrument or mounted adjacent to the primary measurement or control valve. Plug-in units have brought an entirely new concept in maintenance and repair; it is now possible to switch to re-

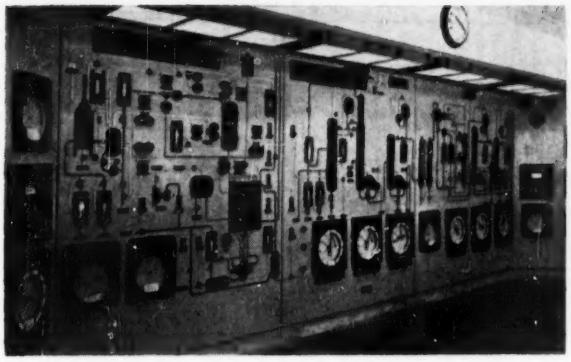

Fig. 5 A graphic panel for a complete refinery process.

mote manual operation, remove a defective unit, and plug in a spare in a few seconds. Some of the newest recorder units can be remote without even switching to remote manual control. All this is done without disturbing the process.

A stack-type controller may be mounted directly on the control valve, as shown illustrated in Fig 8. This is particularly desirable on high-speed-response systems, such as flow or pressure control, especially where large or sudden load changes occur.

High-speed-response Systems

Dry-type vs. Mercury-type Flowmeter Response

One instrument company recently studied reaction rates of a flow-control installation, comparing an aneroid- and a mercury-type transmitter (Fig. 9). The length of tubing between the transmitter and receiver-controller, or between the receiver-controller and the control valve, could be varied from 10 feet to 1,000 feet. The volume of the control-valve diaphragm could be varied and a valve positioner could be cut in or out. The results of these tests indicate the over-all results that may be expected from similar hook-ups.

Fig. 10 shows the lags involved when using a mercury- or aneroid-type transmitter with variable lengths of transmission tubing. With 100 feet of tubing, the time constant (time to reach 63.2-percent recovery from a step change in variable, including dead time) of the aneroid transmitter is 0.9 second, whereas the mercury transmitter has a time constant of 9.5 seconds.

Fig. 11 shows that the lags produced by tubing between the controller and the valve are greater than the lags produced by the same length of tubing between the transmitter and the controller; however, if a valve positioner is used, the difference usually cancels out.

From the series of tests, the following conclusions were drawn:

(1) Dead-period lag (the interval between a process change and the initial movement of the pen recording the change) is increased with an increase in transmitter tubing, controller tubing, and diaphragm-motor size (volume).

(2) Dead-period lag is slightly greater with a mercury-manometer transmitter than with an aneroid type, with other conditions constant.

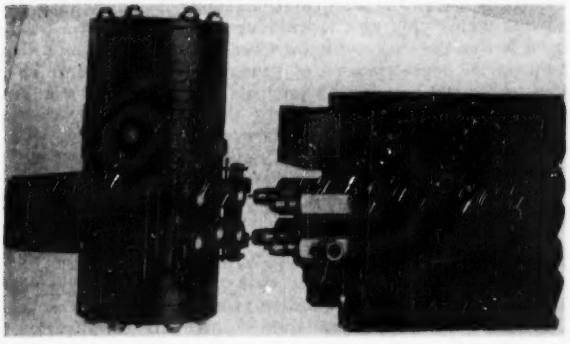

Fig. 7. Plug-in controller.

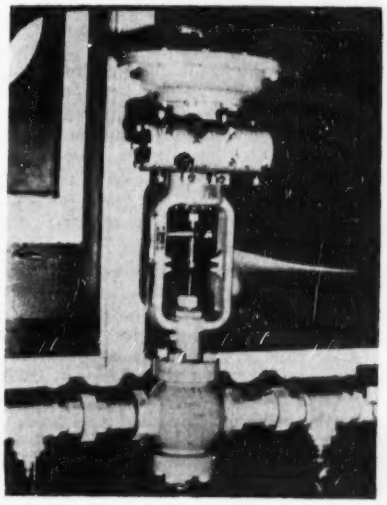

Fig. 8. Stack-type controller mounted on control valve.

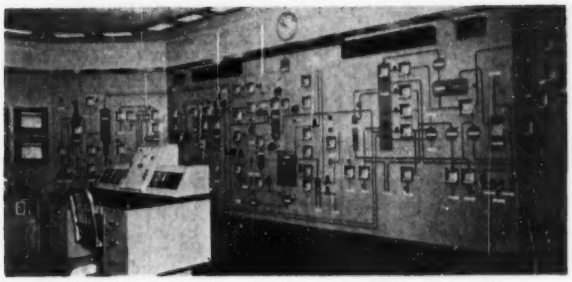

Fig. 6. A full graphic panel.

(3) Dead-period lag is greater when tubing is between the controller and valve than when the same length of tubing is between the transmitter and controller, provided no positioner is used.

(4) In some instances, a valve positioner increases the dead-period lag.

Electronic Transmission and Control Systems

Electronic transmission is faster than pneumatic transmission and, therefore, has advantages—provided it is used with a high-speed primary measuring device and a high-speed final control element.

The primary disadvantage to the petroleum field has been the need for explosion-proofing electrical equipment, which runs up the installation cost. However, the recent liberalization of Section 500 of National Electrical Code now allows most thermionic tubes to be used in Class 1, Division 2 (low hazard) areas; a great many installations will fall in this bracket.

Another trend which is favorable to the use of electronics is the recent practice by some oil companies of classifying centralized control houses as non-hazardous and permitting general-purpose wiring, except for alarm units which are usually hermetically-sealed arcing devices (Class 1, Division 2). Control houses can be classified as non-hazardous in a hydrocarbon processing unit area because (1) no hydrocarbons are brought to the house, and (2) an explosives alarm is installed in the control house and is set below the lower explosive limits of the particular gases that might find their way to the house. When the alarm sounds, the operator knows that it is not safe to operate any of the general-purpose manual switches and, as the automatic alarm arcing devices are hermetically sealed, no hazard exists. Other advantages claimed for the electronic systems are: (1) simplified maintenance with plug-in radio-type construction, (2) infinite controller sensitivity without fric-

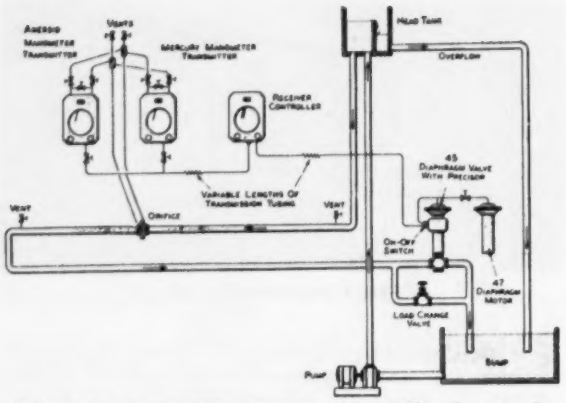

Fig. 9. Set-up for comparing response rate of aneroid- and mercury-type transmitter in a flow-control installation.

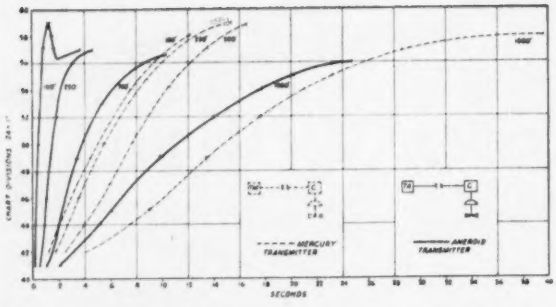

Fig. 10. Transmission lags between transmitter (aneroid- and mercury-type) and receiver-controller (using 45 motor and no positioner) for various lengths of tubing.

tion or hysteresis, (3) elimination of freezing and plugging problems, and (4) essentially no limitations on distance between control elements.

Computers

1. *Definition of "Computer Control."* Computer is an inaccurate name for this type of instrument. They are called computers because computation is the only job so far assigned to them. A more apt term might be "information machine." The machine develops information as predetermined by the operator.

2. *Types.* Currently there are two types—analog and digital. An *analog machine*, as the name implies, uses an analog of the problem to be solved, the process to be controlled, etc. The analog may be electrical, pneumatic, hydraulic, mechanical, or combinations. A slide rule is an analog machine used for computation.

A *digital computer* works by counting. Data on the problem is fed into the machine in numerical form; the machine processes this information in accordance with rules of arithmetic and other formal logic. The answer is also in numerical form. Digital machines can be built with a "memory" to store information to be used at a later time. An analog machine has no memory—the output is instantaneous and continuous.

3. *Present State of the Art.* At present there is no single commercial "information machine" on the market to control all the variables of a given process. Most manufacturers and would-be users are just becoming aware of the possibilities of these machines. A vast amount of coordination and research will have to be done before the widespread application of information machines to process control is economically feasible.

4. *The Future.* Fig. 12 is one concept of an information-machine control system. Block A represents an *analyzing system* for the crude charge; information on temperature, gravity, viscosity, chemical composition, etc., is fed into the Information Processing Center (Block E). The analyzing instruments feed analog-type data to the processing center, which is of the digital type. Two paths of information are shown—one for transmission from the analyzing system to the processing center, the other for transmission of instructions from the processing center to the analyzing system.

Block D represents an analyzing system for the end products. Blocks B and C represent steps in the process proper; Block B might represent a top-pressure control on a Debutanizing Column, while Block C might represent flow of reflux. Should the Debutanizer Feed vary in composition or charge rate, a change in temperature may be called for. Instructions can be stored in the machine for calculating the temperature necessary to produce the end-point product; the machine will make the necessary calculations and corrections. The same is true if the end-point composition varies. By feeding into the processing machine information on predicted market inventories, the machine can direct the plant to produce the products yielding the highest returns within the limits of the processing equipment.

Data and records will probably be kept in digital form—on punched card, tape, magnetic tape, and log sheets. The log sheet may be similar to today's, but will be printed automatically.

As processes increase in complexity and speed, information machines will become necessary. The entire process will have to be designed for controllability and flexibility.

Nuclear Instrumentation

Radioactive isotopes are finding application in the oil industry, both in research and process control. Inexpensive radioisotopes are available from the reactors of United States, Canada, and Great Britain.

A few examples of the usefulness of radioactivity are presented below. This is not intended to be a complete report on any investigation or to cover all the applications.

Radiography

The largest single industrial application of radioactive isotopes in the United States (76,000 millicuries of Iridium, atomic weight 192) was used recently for radiographic inspection of a reactor at a large Texas refinery. It was the first time that isotopes were used to look for hydogen blisters in the steel of a refinery reactor unit.

Fractionating Tower Flow Pattern

A major California refinery has carried out a flow pattern study in a large vacuum tower by injecting approximately 3 millicuries of an oil-soluble antimony compound into the reflux line. Geiger-Mueller counters were used outside the tower to follow the flow pattern of the tagged reflux. By measuring the time of the cycle of the tagged reflux it was possible to calculate the total hold up in the system. The cost of the 3 millicuries of antimony was approximately $8.00.

Location of Interface

In a product pipe line where a number of different products are handled in one line, several of the oil companies are now injecting radioactive materials whenever a product change is made. The pump stations along the route have detectors which pick up the interface between the two products, letting the operator know when to switch tanks in order to keep the contamination of products to a minimum. This eliminates reprocessing of products and minimizes grading of products. It also permits more than one company to use the same pipeline, and have an accurate indication of the interface between the differently owned products.

Some companies have provided automatic control through radioactivity detectors and relay circuits to switch valves automatically.

Flow Studies

Radioactive catalyst beads were used to determine flow patterns and catalyst circulation rate in a catalytic cracker. For this work catalyst beads are tagged with 1 millicurie of

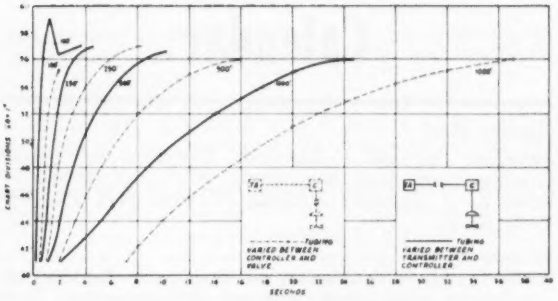

Fig. 11. Comparison of lags produced by tubing between controller and valve with lags produced by equal tubing between transmitter and controller.

zirconium-95, and the radioactive beads are placed in the system. The Zr-95 is a gamma-emitting radioisotope worth $2 per millicurie. Two sets of Geiger tubes are placed 25 to 50 feet apart along a catalyst stand pipe. The two sets of Geiger tubes determine the time required for a radioactive pellet to pass between them. This time is fed into a computer into which is also fed the density of the catalyst; the result is a plot of tons per hour of circulation. One charge of radioactive beads lasts for several months.

Level Measurement

The level of liquid or a solid in a closed vessel also can be determined by a gamma-ray source placed in or at the side of the vessel. Radiation moving in a horizontal direction traverses the liquid or solid if its level is above the source; on the other hand, the rays pass through air or vapor if the level is below the source of radiation. Thus the amount of gamma rays transmitted (as indicated by a Geiger-Mueller counter at the same height on the opposite side of the vessel) changes abruptly at the level of the liquid or solid surface. The same principle can be used for liquids or solids of different densities (interface) in the same vessel.

Other uses for gamma radiation are for determination of liquid densities and bulk densities of granular solids.

Another successful application is measurement of granulated catalyst levels in catalytic-cracking-unit storage hoppers and operating surge vessels. The radium source is placed in wells inside the tower; the Geiger-Mueller counter is placed at the highest elevation the level can attain. The greater the amount of catalyst between the source of radium and the detector, the less the amount of energy detected; therefore, the level can be automatically recorded or controlled by electronic circuitry.

The problems susceptible to solution with radioactive isotopes and analytical tools are as varied as the imagination of the investigators.

ACKNOWLEDGMENTS

(1) George Miller, The Fluor Corporation, Ltd.
(2) William Carmack, The Fluor Corporation, Ltd.
(3) William J. Berk and George E. Howard, *Taylor Technology*, (Taylor Instrument Companies).
(4) J. Kohl, Tracerlab, Inc.

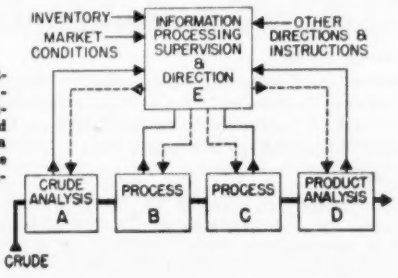

Fig. 12. Typical set-up using a digital-type processing center to control end product, using data from analog-type pickups, market conditions, etc.

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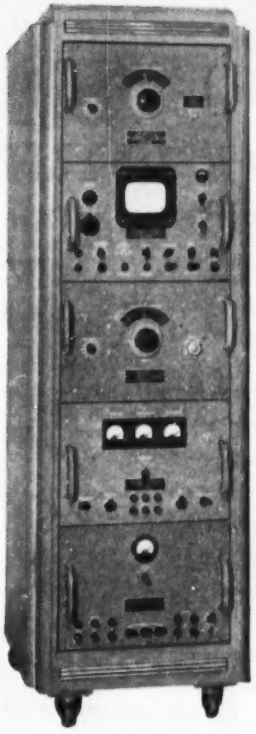

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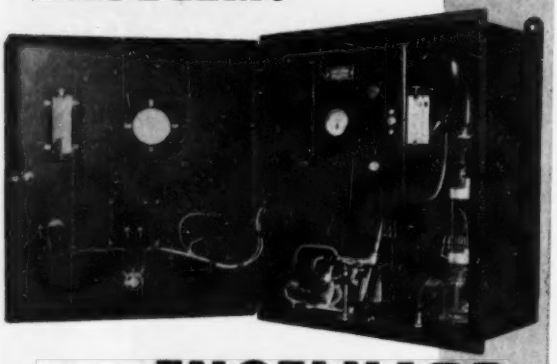

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January 28-30

High-Speed Computer Conference presented by Louisana State University, to be held at the campus. For information contact Dr. Megginson, Louisiana State University, Baton Rouge, Louisiana.

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Symposium on Instrumental Analysis, presented by the Chicago Section, Instrument Society of America. For information write George R. Kincaid, c/o Beckman Instruments, 7145 W. Belmont Ave., Chicago 34, Ill., or H. C. Roberts, 511 W. Washington St., Urbana, Ill.

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April 6-9

Conference on Physics of Particle Size Analysis, sponsored by the Institute of Physics, Nottingham, England. For information write Institute of Physics, 47 Belgrave Square, London, S. W. 1, England.

SOAKING PIT

(*Continued from page* 131)

necessary additional air from the tile recuperator to maintain a required air pressure in the header supplying combustion air to the pits.

Fig. 7 illustrates the method used to measure *combustion air* to each pit. A Venturi tube is located in the pit air header at the inlet to the burner port. One impulse tap is located in the air header; the other in the Venturi throat. The differential is imposed on an air-flow measuring device, which is a part of the air-fuel control system.

Fig. 8 shows the primary element used for *temperature measurement.* It is mounted in the back wall of the pit and consists of a closed-end silicon-carbide fyrestan-lined tube. A "Rayotube" is mounted at the open end of this target tube; the millivoltage generated is transmitted to the pit-temperature recorder-controller.

Fig. 9 shows the *pit-temperature control arrangement.* The pit-temperature recorder-controller is set for the desired control temperature and sends a signal through the pit-cover trip-relay (used to shut off the combustion air when the pit is opened) to the air-control-valve operator, which positions the air control valve to supply the required amount of air to the pit burner. An air-flow signal is received by the flow-measuring unit, which sends a signal to the air-fuel ratio adjuster from which an actuating signal is transmitted to a relay in the gas control system. The combustion-air temperature compensator, in the air-flow recorder, corrects air density fluctuations caused by variations in combustion-air temperature.

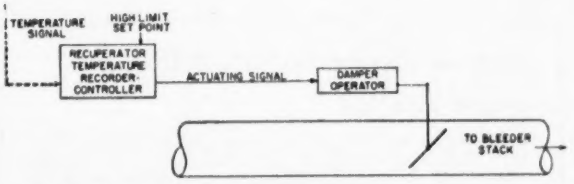

Fig. 12. Bleed control for protecting the metallic recuperator from overheating.

Fig. 10 shows the *fuel-control system.* The actuating signal from the air-flow measuring unit is received by a control relay, and is sent through the pit-cover relay to the fuel-valve operator which positions both the gas-control valve and the oil- and steam-control valves. The oil-flow and gas-flow measuring units transmit a signal to the fuel valve selector, which may be set to supply gaseous or liquid fuel for pit firing. The flow-measuring units are adjusted so that the signals sent out are on an equal BTU basis; therefore, no change in the control relay is necessary when converting from one fuel to another. The recorder-integrator records the coke-oven-gas equivalent of either fuel.

Fig. 11 shows the *gas and fuel-oil transmitters* and valves which are mounted on the same floor level behind the control houses. A transmitter, installed in the fuel lines to each pit, converts the fuel measurement to an air impulse signal.

Fig. 12 shows the *bleed control* used to protect the metallic recuperator from overheating. A thermocouple near the outlet of the recuperator is connected to a temperature recorder-controller that sends a pneumatic signal to the operator positioning a valve in the bleeder stack. The outlet of this stack is connected to the air inlet of the tile recuperator.

Fig. 13 is a layout of the *safety interlocks* incorporated in the combustion-control system. It consists of pressure switches and a three-way trip valve designed to bleed the instrument air to atmosphere should there be a failure of electric power, instrument air, gas pressure, or combustion-air pressure. The damper and valve-control operators are designed so that they will travel to a closed position with control-air failure.

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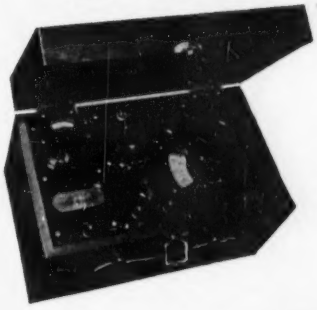

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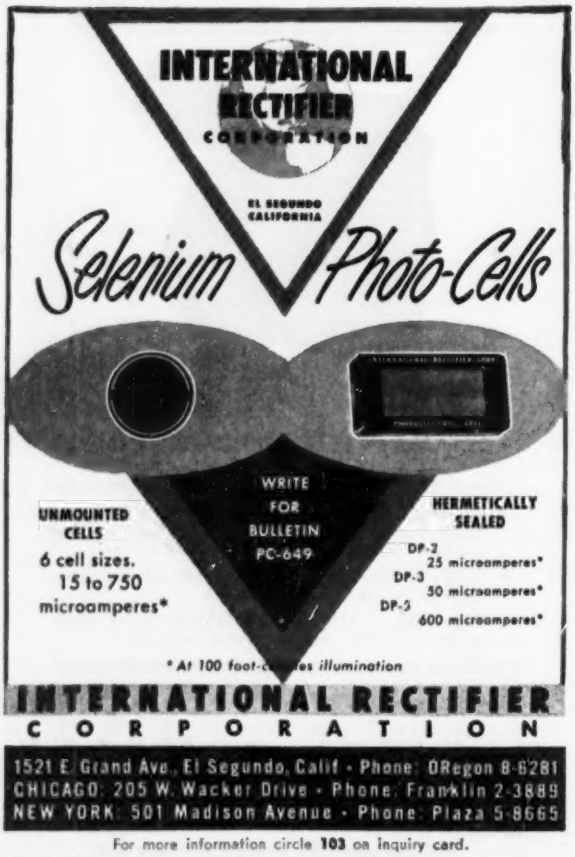

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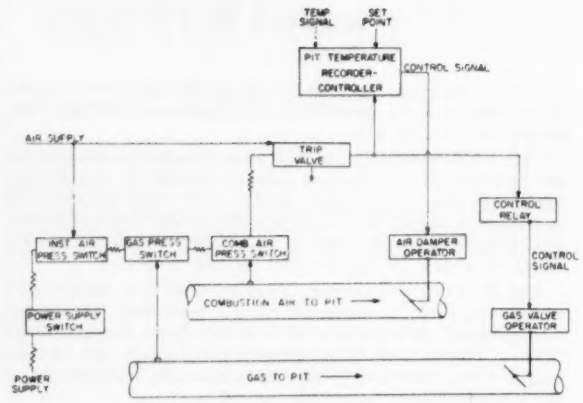

Fig. 13. Safety interlocks in the combustion-control system.

the plant compressed-air system; an auxiliary air compressor is provided to automatically supply the instrument air in event of failure in the plant air system.

In addition to selection of the proper instruments, controls, and related equipment, there are other items which must be considered—pipe line, sizing, control-valve characteristics, liquid-fuel reheaters, connections for test apparatus, check gauges to indicate corresponding control functions, etc. In conclusion, it is of primary importance to install the equipment in suitable locations to make it readily accessible for inspection and servicing.

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OXYGEN MEASUREMENT

(*Continued from page* 129)

turbances created by bubbles interfered with formation of mercury droplets, rendering readings unreliable.

To obviate this second difficulty, the rotating platinum electrode was developed. It has the following advantages: (1) The stream of rising air bubbles does not interfere with its operation; disturbances do not affect it because its operating principle is based on extensive mixing in the immediate vicinity of the platinum wire. (2) Records are continuous smooth lines. (3) It is less bulky, sturdier in construction, and more easily operated and maintained because the electrode is fixed and the problems of handling mercury are eliminated.

Difficulty has been experienced with the electronic equipment, especially the amplifiers. Although voltage stabilizers are included in each circuit, there is still need for periodic adjustment of the zero reading, which has a tendency to drift. One disadvantage of the rotating platinum electrode is that the wire tip must be kept polished, which necessitates wiping it off with fine sandpaper about once a day. This probably restricts the instrument to clear waters.

Recommendations with regard to the two oxygen-measuring systems include (1) incorporation of calibrated resistances corresponding to a specific temperature to compensate for the variation in temperature of the water, (2) determination of the effect of variation in rotational speed on the current with the platinum electrode, and (3) effect of extremely high turbulence on the platinum electrode.

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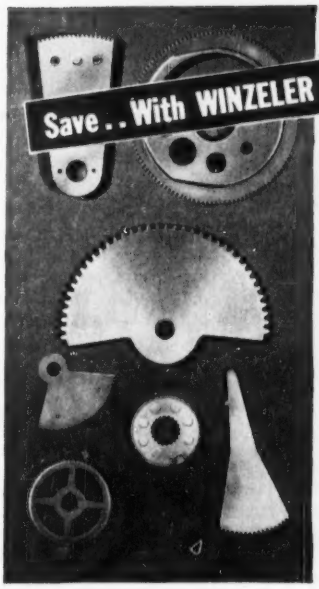

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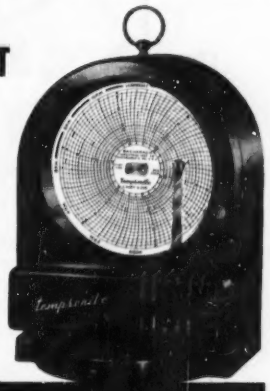

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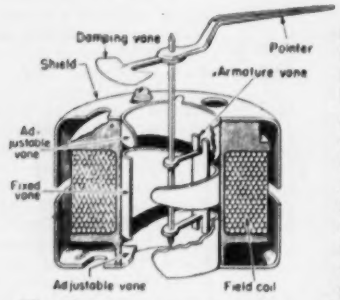
Briefs . . .

Moving-iron Instruments

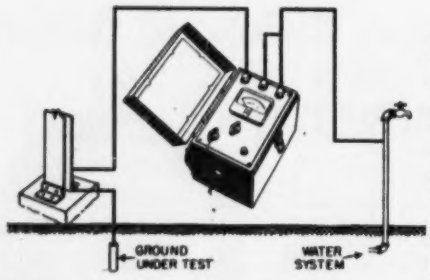


A-C voltmeters and ammeters of the moving-iron type utilize a mechanism that combines the attraction and repulsion principles of operation. A fixed vane and two adjustable vanes of carefully determined configuration are mounted inside of a field coil, which, when energized, magnetizes these vanes. The fixed vane exerts a force of repulsion in the direction of the taper, or up-scale. The upper and lower adjustable vanes attract the moving iron in the direction of increasing vane width, or up-scale.

Cup-shaped shields, fitted over the coil ends, increase the sensitivity, and can be rotated to control the instrument scale distribution. (*From the new General Electric Bulletin GEC-218C, which also describes wattmeters, synchroscope and power-factor meter, etc.*)

For literature circle **501** on inquiry card.

Earth Resistivity



Protecting electrical systems and specific equipment with good man-made grounds is not only an important personnel safety measure, but also a valuable safeguard against damage or destruction of equipment through superimposed voltages from other circuits or from lightning. Testing of man-made grounds with Vibroground is the fast, accurate way to be certain that grounds provide maximum protection. (*From the new Associated Research Bulletin* 1-1)

For literature circle **502** on inquiry card.

The Potentiometer

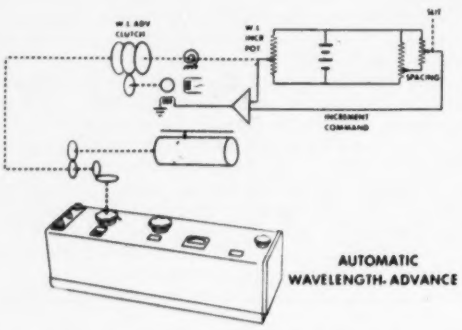
A potentiometer is an instrument for measuring voltage without drawing any current from the source being measured. Since there are many places where drawing any current would change the voltage reading, the value of the potentiometer is obvious.

The potentiometer operates by opposing an adjustable known voltage to an unknown voltage. A sensitive galvanometer between the two acts the same as the pointer on a balance and indicates which side is "heavier" or has the higher voltage. The operator adjusts his potentiometer until the galvanometer pointer is on zero—showing that the two voltages are balanced. The potentiometer reading then equals the value of the measured E.M.F. (*From new Gray Bulletin E-18*)

For literature circle **503** on inquiry card.

Automatic Spectrophotometer

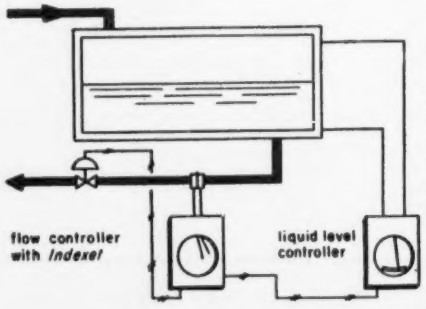
The most common use of this instrument will probably be the automatic, unattended plotting of curves. It is quite flexible, however, and may also be used semi-automatically or manually.



In plotting a spectrum it is often desirable to take a few test points first to check regions of interest, and sometimes to find a suitable concentration. On maximum spacing the instrument will take 20 points across the coarse scale in three minutes . . . The instrument will have taken only the measurements actually required, at a considerable saving in running time. (*From new Beckman Bulletin* 95*D3 Reprint R-58*)

For literature circle **504** on inquiry card.

Remote Controller-index Setting



Where closer control of level is required than could be attained if the liquid level controller directly operated the valve in the outflow line from the tank, a cascade control system can be used. In this system the output air pressure from the liquid level controller operates an *Indexet* mechanism in a flow meter that controls the valve in the outflow line from the tank. In this way any changes in conditions affecting the secondary variable, flow, are immediately corrected by the flow controller. Changes in outflow might be caused by such factors as variations in line pressure. (*From new Minneapolis-Honeywell Bulletin* 8930.)

For literature circle **505** on inquiry card.

Frac.-hp.-motor Selection

The a.c. motor has the following advantages over the d.c. motor—absence of brushes and commutators greatly increases the life of the unit—absence of brushes and sparking also eliminates the r.f. interference problem—gives far more reliable performance with regard to torque

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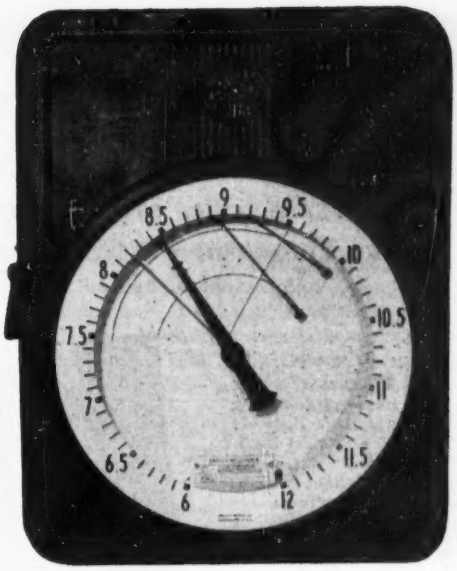

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✓ Resistance thermometer operation over a complete range from –300F to 1200F has been made possible by Bailey's development of a low-cost platinum resistance element.

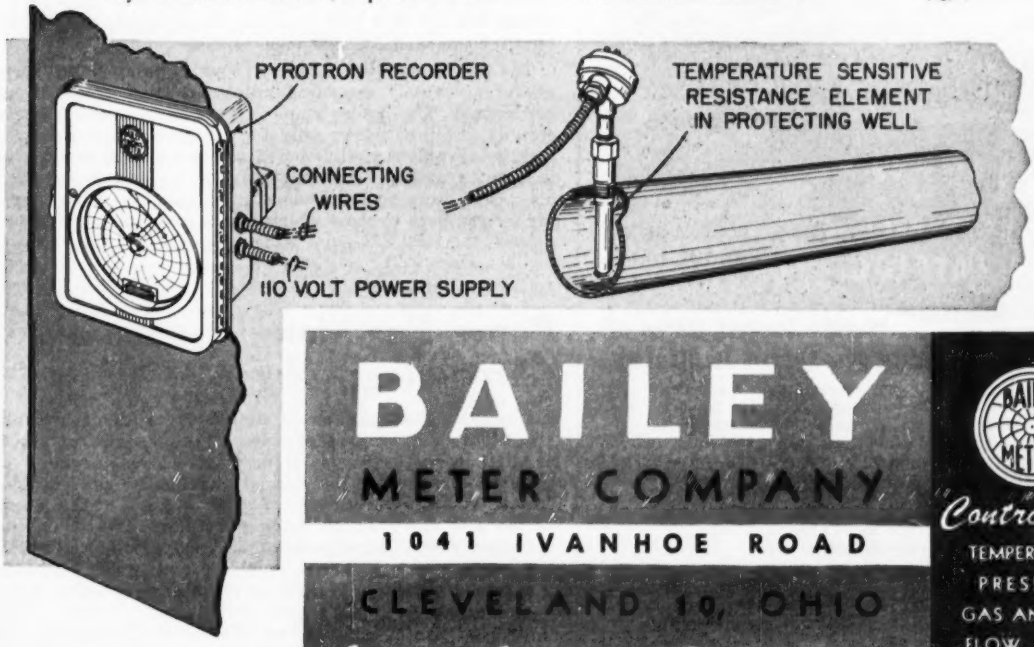
✓ Resistance thermometer operation requires no standard cell, dry battery and cold junction compensator. Uses 115 volt a-c source. Strong signal and high precision of resistance element as compared to thermocouple makes possible the use of narrow range spans.

✓ The Bailey Pyrotron is calibrated at the factory and *remains* accurate; no periodic re-calibrations required. Since all elements are matched it is not necessary to calibrate each recorder to its element.

✓ Recorder is sensitive to 1/10 of 1% of range span.

✓ Ordinary copper lead wires permit remote location of recorder with respect to the temperature sensing element.

✓ For complete information, write for bulletin 230-C on the Bailey Pyrotron Electronic Resistance Thermometer. P-27-1



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by Donald C. Duncan

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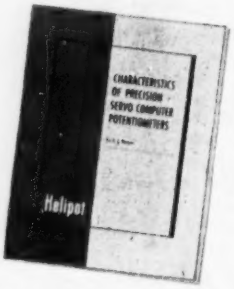

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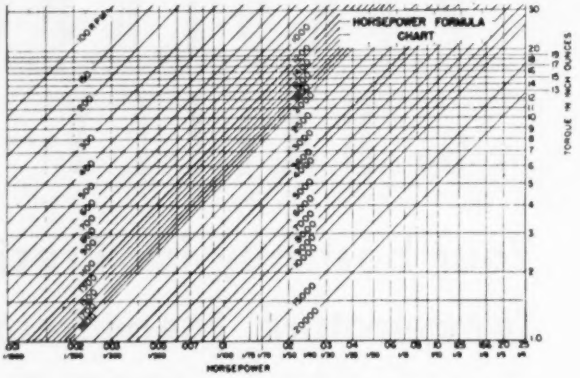


and speed characteristics; a very important consideration in many precise systems now in use.

The a.c. motors now in use can generally be broken into three frequency classifications; 60 cycles, 400 cycles, and variable frequency (320-1800 cycles and 50-60 cycles). 400-cycle motors have a higher output per unit weight and volume. However, it must be remembered that 400 cycle operation is usually less efficient than 60 cycle operation and the higher speeds decrease overall life expectancy and increase service problems—variable frequency units have poor efficiency and performance characteristics when compared to single frequency motors since they are a result of many compromises in design. (*From new brochure "Subfractional Horsepower Motors—End Applications and Selection" by Air Marine Motors, Inc.*)

For literature circle **506** on inquiry card.

Static Magnetic Memory

The Static Magnetic Memory operates essentially as a magnetic trigger pair which requires no vacuum tubes to maintain position. The trigger pair action depends on the state of the core material being represented by a point at either the top or bottom of the hysteresis loop. This necessitates the use of a core material whose hysteresis characteristics approximate the ideal square loop.

The Static Magnetic Memory provides an excellent measure of accurately recording pulses at rates up to 25,000 per second. The device employs no complex vacuum tube circuits, requires power only for circulation and none for storage of pulses, and imposed no restrictions because of inherent fragility. The unit may be applied to counting operations ranging from those using rapid electronic pulsing mechanisms to those of lower speed machine operations. (*From the new 320-page Alden Handbook "Ideas—Techniques—Designs"*)

For literature circle **507** on inquiry card.

Paper Partition Chromatography

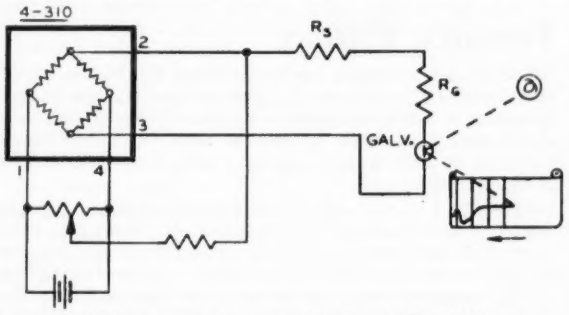
Photovolt Densitometer is designed for the convenient and accurate evaluation of color spots on strips or sheets of filter paper obtained by partition chromatography or paper electrophoresis . . . Special attachments are available for the speedy measurement of paper strips, but the length of the arm also permits readings on large sheets. The instrument covers all aspects of chromatographic and electrophoretic work. It is also useable for other densitometric purposes such as the evaluation of autoradiographs, X-ray negatives, etc. . . . The basic instrument consists of two units—a Density Unit and an Electronic Photometer. For convenient evaluation of paper strips, the Density Unit can be equipped with a scanning stage incorporating a

mechanism that permits advancing of the paper strips in steps of 1 mm. By marking the density readings along a straight edge on the graph paper, a complete density curve is obtained in a semi-automatic manner. (*From the new Scientific Glass Apparatus Co. "Whats New" No.* 19)

For literature circle **508** on inquiry card.

Miniature Pressure Pickup

One of the smallest instruments of its type ever designed for quantity production, the new "Star-Type" 4-310 Pressure Pickup is outstanding not only in its size but also in



its negligible temperature sensitivity, insensitivity to acceleration effects and wide adaptability to many test conditions and mounting requirements. Applications range from turbulence investigations in wind-tunnel work to surveys of hydraulic-system pulsations and pressure-surge patterns in pumps and processing equipment. Illustration shows transducer used in a direct-recording system. (*From new CEC Bulletin* 1534*A*)

For literature circle **509** on inquiry card.

Mutual-conductance Tube Tests

The mutual conductance test was first introduced by Hazeltine in 1919 . . . Because conductance is the opposite of resistance, the name MHO (ohm spelled backwards) was adopted for this unit of measurement.

Conductance being the opposite or resistance, the greater the conductance of a tube, the easier it is for electrons to flow through it. Mutual means pertaining to two or more related things. All constants of the tube are considered when measuring mutual conductance . . . Dynamic pertains to motion. In measuring Dynamic Mutual Conductance, the tube must be working. To simply take an emission reading is not enough, because the tube is not working.

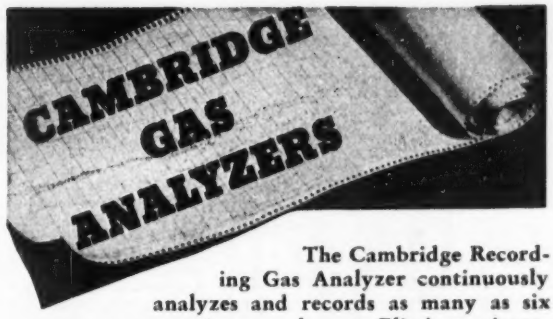
The three principal characteristics of a vacuum tube are mutual conductance, amplification factor and plate resistance. To measure the amplification factor or plate resistance alone will not give a measure of the value of the tube. But mutual conductance is tied in such a way with amplification factor and plate resistance that mutual conductance is the quotient of amplification factor divided by plate resistance. It is thus seen that when we measure mutual conductance we automatically take into consideration both the other two characteristics. So, mutual conductance is a 3-in-1 measurement. (*From new Hickock Form TT-5A*)

For literature circle **510** on inquiry card.

Pneumatic Power Positioner

The Foxboro "Poweractor" positioner provides fast, sensitive and precise positioning of powerful cylinders or springless pneumatic diaphragm motors and similar devices.

This unique relaying device converts a standard 3-15 psi pneumatic controller signal into a high pressure pneumatic



The Cambridge Recording Gas Analyzer continuously analyzes and records as many as six constituents of a gas. Eliminates intermittent, slow and expensive manual gas analysis. Accurate . . . Sensitive . . . Simple. No moving parts; utilizes thermal conductivity principle.

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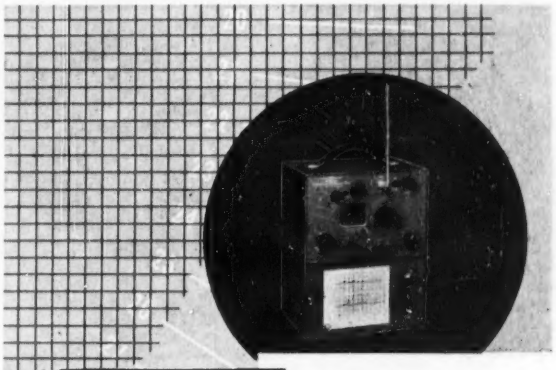

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For more information circle 112 on inquiry card.

BRIEFS—CONTINUED

differential to position a piston or other springless operator —without additional relays.

Remarkably fast in response and in action, the Poweractor accurately positions through a simple, force-balance mechanism. Produces up to 20,000 lbs. of force (16" cylinder with 110 psig.) Piston responds to as little as 1" of water change in signal pressure. Positions to better than 1 percent of total stroke under normal loading conditions. (*From new Foxboro Bulletin* 473)

For literature circle **511** on inquiry card.

Toroids, Filters

The TC-1 . . . might easily be called the "work horse" of all toroids. In the earlier days of toroidal filters and networks, it was most popular because of its nominal size and weight, and high Q over a wide frequency range. Today it is still widely employed where miniaturization is not essential.

Type TC-T tone channel filters for multiplex telegraph receiving and transmitting systems are available in a variety of band widths and standard channel spacings, at all frequencies from 425 cycles to 3825 cycles. In addition to the standard design filters as illustrated in the above charts, filters can also be supplied with a wide variety of band pass characteristics. (*From the new* 12*-page Catalog* 101*A of Burnell & Co., covering toroids, coils, and filters.*)

For literature circle **512** on inquiry card.

Balanced-action Hand Valve

Balanced-Action means that the flow through the valve may be in either direction and that the valve will positively open . . . The Henry Balanced-Action Diaphragm Packless Valve is non-directional . . . Valve will operate at pressures up to 300 P.S.I., regardless of direction of flow. For higher pressures up to 500 P.S.I., direction of flow must be under valve seat . . . Valve will operate even if a high vacuum exists under the seat. This condition is frequently encountered when pumping down or evacuating a part of a system. (*From Henry Valve Co., Catalog* 101)

For literature circle **513** on inquiry card.

Decade Counter Stage Uses Glow-transfer Tube

The Norelco Decade Stage utilizes the New E1T counter tube—designed principally for the counting and indicating of electrical pulses. It can successfully replace several electronic tubes, plus their indicator lamps and associated components. In a single glass envelope, the E1T possesses the structure which permits it to count to ten—and to indicate the count by bright fluorescent number. A second tube, type 5964, performs the pulse-shaping function between stages. (*From North American Philips Co. new* 4*-page technical bulletin*)

For literature circle **514** on inquiry card.

Ball-bearing Inspection

When one race rotates with respect to the other, irregularities of contour produce a complex cam action between the two races . . . The character of the noise and vibration depends on the height, shape, and spacing of the waviness irregularities on (1) the inner raceway, (2) the balls, and (3) the outer raceway.

The Anderometer gives a numerical rating of the combined waviness of the balls and raceways of assembled ball bearings. The unit of measurement is called the anderon, and takes into account both the angular spacing and amount of "throw" of the complex cam action caused by

this combined waviness—in terms of microinches of height and number of "throws" per circumference. The anderon is defined in detail in the Anderometer Technical Manual, available on request. (*From the new 4-page bulletin of Micrometrical Mfg. Co.*)

For literature circle **515** on inquiry card.

Magnetic Impulse Counter

The Kellogg Magnetic Impulse Counter is a selector switch of revolutionary design. It is used to solve many switching or control problems where the intelligence to be registered, stored, and released is supplied in the form of electrical pulses. It has a wide application in the fields of industrial control, computer design, telephone, VHF radio, microwave selective signalling and telemetering. The unit may be used in many systems where trains of impulses are recorded or used to control a variety of circuits. Under proper conditions the impulse rate may be as high as 20 per second.

For many years the stepping switch, in one form or another, has been used. The moving elements of all such units have a comparatively large mass. This introduces excessive inertia, wear, vibration and noise. The large mass also limits the speed, accuracy and life of these units. The Kellogg Magnetic Impulse Counter reduces these objectional features of the stepping switch. (*From the new 4-page bulletin of Kellogg Switchboard*)

For literature circle **516** on inquiry card.

Moisture Measurement

Moisture content of granular and powdered type materials is of vital importance throughout every stage in manufacturing, storage, buying and selling. Excessive

ELECTRIC and PHOTO-ELECTRIC COUNTERS for every job

HEAVY DUTY ELECTRIC COUNTER

SMALL NON-RESET

SMALL PANELMOUNT RESET

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For more information circle **114** on inquiry card.

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Increasing flow overcomes downstream line losses by jet tube venturi action in the Kendall Model 10

IS IT FREEDOM FROM SUPPLY PRESSURE INFLUENCE?

50 PSI variation in upstream pressure will result in less than 0.05 PSI change in downstream pressure on dead end service when you use a

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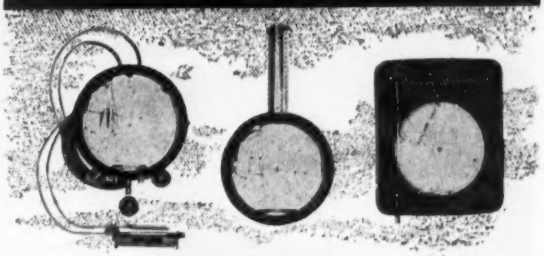

No matter what problems you face in obtaining suitable humidity measurements and records, the unique versatility of Foxboro Humidity Instrumentation offers an appropriate solution. Included are Recorders, Recorder-Controllers, Indicators, for relative humidity (hair and membrane), wet-and-dry bulb measurements, and for direct reading dewpoint or absolute humidity measurement (with the exclusive Dewcel element). Available in portable, close-coupled and long-distance types; with round or rectangular cases.

Write for full details in Bulletins 188-5 and 407. The Foxboro Company, 451 Norfolk St., Foxboro, Mass., U.S.A.

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Wherever temperature readings are required—on the production line, in the laboratory or in the field—this sturdy precision instrument can bring you instant, accurate results.

It's Fast... In operation and quickly read. Precision movement designed to laboratory standards. Direct reading scale face is easily understood—no slide wires or conversion tables necessary.

It's Accurate . . . consistently to within ¾ of one percent under almost all variable conditions. Sturdy, protective case assures continued accuracy in toughest portable service. Ten scale ranges available, from 0-400° to 0-3000°F. Equivalent Centigrade scales available at no extra cost.

It's Portable... compact size, 6½"x6"x3", and light weight make this pyrometer highly portable and easy to use anywhere. Write today for complete details and prices. Illinois Testing Laboratories, Inc., Room 518 420 N. La Salle Street, Chicago 10, Illinois.

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BRIEFS —CONTINUED

moisture in materials bought on a weight basis means wasted dollars . . . effect the cost and speed of production . . . can mean deterioration or spoilage.

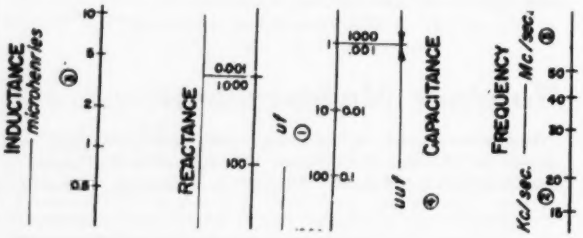
The fundamental way of determining moisture content is by the oven-scale method, or the various distillation methods such as Bidwell-Sterling, Karl-Fischer, or Toluene. The laboratory methods give very accurate results when top grade equipment is operated by skilled technicians. Seldom can such equipment be placed on the production line where most needed.

Thus electronic instruments have been developed for quick and accurate moisture checking in the plant. Once calibrated against standard methods, these instruments can be used for direct testing without further laboratory work. (*From the new 4-page bulletin of Electronic Moisture Register Co.*)

For literature circle **517** on inquiry card.

Reactance Nomograph

One of the handiest nomographs to have on hand is the reactance nomograph, which gives the reactance of any



capacitor or inductor at any frequency. (A reactance nomographs, plus many other charts and tables useful in electronic design is available in the *new 20-page Airton brochure "Microwave Nomographs and Charts."*)

For literature circle **518** on inquiry card.

Ayrton Shunt

The Ayrtron shunt is a useful instrument for use in conjunction with a galvanometer in practically all circuits where a galvanometer is used as a detector. Its chief purpose is to regulate the sensitivity of the galvanometer. It does this by shunting the available galvanometer current through a resistance so that the galvanometer current is 0.001, 0.01, 0.1, or full value. (*From new Gray Instrument Co. Bulletin E-17, which also describes resistance standards, Wheatstone and Kelvin bridges and Kohlrausch's slide wires for resistance measurements.*)

For literature circle **519** on inquiry card.

X-ray Fluorescence Quantometer

A new instrument which has been perfected for the rapid chemical analysis of materials by use of x-ray fluorescence was recently announced by Dr. Maurice F. Hasler, president of the Applied Research Laboratories of Glendale, California . . . X-ray Quantometers enable the rapid, nondestructive chemical analysis of metals, powders, and liquids . . . The speed of analysis obtained with this equipment is many times faster than that previously thought possible.

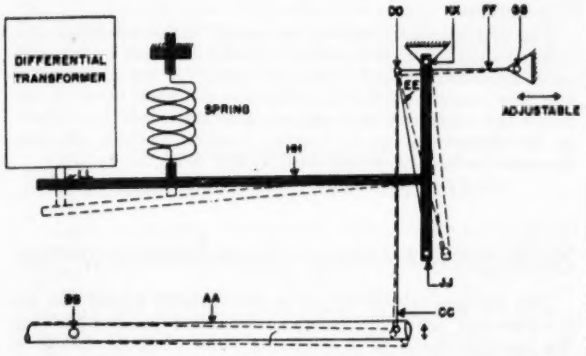
Applied Research Laboratories is currently manufacturing gauges which use the principles of x-ray fluorescence

for the measurement of the thickness of tin plate on steel. Accuracies as great as a millionth of an inch are expected while the plated steel is passing through a mill at 1200 feet per minute. This application brings the automatic factory of the future one step closer. (*From the new Applied Research Laboratories "AIRLife"*)

For literature circle **520** on inquiry card.

Pressure Transducer

An extremely unique mechanism is employed to multiply the very small motion obtained from the pressure diaphragm to a motion of 0.050" suitable for operation of



the differential transformer core. This linkage features a ratio adjustment which is accomplished without any sliding fulcrums, friction type pivots and without the necessity of touching any moving parts of the linkage. (*From new Swartwout Bulletin A-707-A*)

For literature circle **521** on inquiry card.

How to Select Control Modes

System A—Two-Position

1. Batch or continuous processes.
2. On furnaces and ovens that have fairly uniform heating characteristics.
3. When some overshooting and undershooting is not objectionable.
4. Where transfer lag and dead time can be reduced to negligible value.
5. When burners and associated equipment is suitable for "on-off" firing.
6. Size or capacity of equipment is immaterial.

System E—Proportional Position

1. Primarily for continuous processes.
2. When large, rapid load changes are not present.
3. When "droop" is not objectionable or it is not too inconvenient to make manual correction.
4. When process responds rather slowly to change in input.
5. On fuel fired applications where burner equipment does not permit "on-off" firing. (*From the new Barber-Colman Wheelco Bulletin F-6149*)

For literature circle **522** on inquiry card.

Time-interval Measurement with a Counter Circuit

For measuring time intervals, the 522B is arranged with two special terminals. One of these accepts a "start" signal, the other a "stop" signal. The purpose of these terminals is to open and close an electronic gate in the instrument. When the gate is open, a standard frequency from an internal precision oscillator and time base circuits is applied

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Write for Bulletin B-30-D

For larger capacities, write for data on Model A-100.

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For more information circle **118** on inquiry card.

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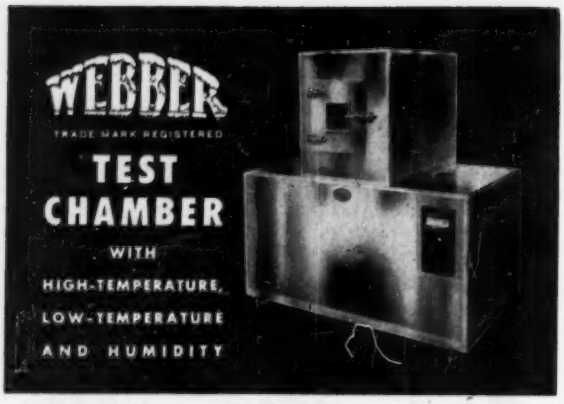

★ This Webber test unit, designed for production and experimental testing, has a temperature range from +250°F., to −100°F. The pull-down to −100°F., is achieved in 45 minutes, and can be cycled from −100°F., to +250°F., in 30 minutes. 95% relative humidity is provided at temperatures between 75°F., and 95°F. Vacuum equipment can be added to simulate high altitudes. The test chamber, provided with a moisture-proof light for illumination, is 4½ cubic feet, 20 inches high, 20 inches wide, 20 inches deep. High and low temperatures are governed by a temperature controller with scale range from −200°F., to +400°F., with a 3 degree control point differential, 1½ degrees plus and minus. The humidity is regulated by a wet and dry bulb controller. Unit size is 60" long, 45" wide, 74" high. Apertures in left side of cabinet provide for electrical cables to energize equipment being tested. Webber offers a complete line of test units for various applications.

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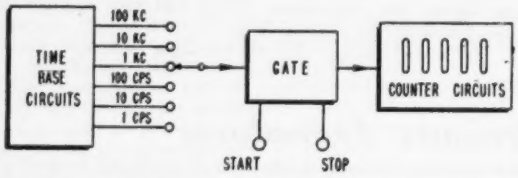


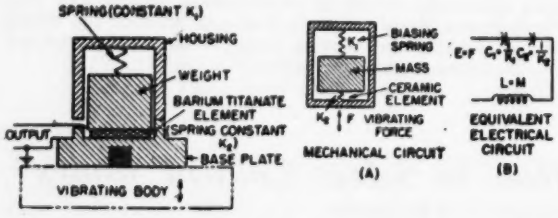
to the instrument's counter circuits. The counters thus measure the number of cycles of the time base circuits that the gate has been open, i.e., the time between the start and stop signals.

The precision oscillator is arranged with associated circuitry so that it makes available to the counters any one of six frequencies spaced in decade steps from 1 cps. to 100 kcs. The counters will thus measure the time interval between the start and stop signals directly in units as short as 10 microseconds or as long as 1 second. (*From the new Hewlett-Packard Journal, Vol. 5, No. 1-2*)

For literature circle **523** on inquiry card.

Self-generating Accelerometers

The piezoelectric principle is particularly suited for accelerometers used in industrial vibration studies because the reaction force of a vibrating body is proportional to its acceleration. A relatively new ceramic piezoelectric is



essentially composed of polycrystalline barium titanate, which combines sufficient piezoelectric sensitivity, high capacitance and good electrical stability.

The voltage sensitivity of the ceramic is not as high as that of Rochelle salt, which exhibits the highest sensitivity of all known materials. This disadvantage, however, is outweighed by a number of desirable features. The conversion characteristic is hardly affected by temperature and humidity. The mechanical strength is greater than that of Rochelle salt crystals. The dielectric constant is higher, which gives the transducer a larger electrical capacitance. This makes it easier to match its electrical output to the input of electrical measuring equipment and permits the use of a long cable between transducer and equipment. Finally, the material can be manufactured easily in any desired size and shape. No precisely made cuts, as in the case of a single crystal, are necessary.

The use of the material for electromechanical transducers was studied by the Signal Corps. The investigation resulted in the development of several types of barium titanate accelerometers. (*From the new 54-page Gulton catalog on barium-titanate accelerometers*)

For literature circle **524** on inquiry card.

Test Chamber Control

CULVER CITY, CALIF.—The temperatures of most automatically-controlled environmental test chambers are regulated by simple on-off controls. Recently, however, Howard Hughes, for his Culver City, California plant, needed a 27-cu.-ft. temperature-humidity chamber which

could be controlled within 1-percent accuracy from 32 to 212 deg. F. Tenney Engineering, Inc., Newark, N. J., recommended "proportional-input" control and, in cooperation with The Bristol Company, developed a temperature control system which regulates chamber temperature within ½ deg. F.

For literature circle **525** on inquiry card.

Nitrogen Atmospheres

The Nitroneal Generator produces pure nitrogen with a controllable hydrogen content by reacting ammonia with air in the presence of the Engelhard catalyst. The apparatus generates a gas completely free of oxygen, consisting only of nitrogen, hydrogen, and water vapor . . . 301 cubic feet of ammonia plus 1070 cubic feet of air will yield 1000 cubic feet of gas resulting in a cost of $2.25 for 1,000 cubic feet, which is many times cheaper than an equal amount of cylinder nitrogen. (*From new 4-page Form 4240A of Baker & Co., 113 Astor St., Newark, N. J.*)

For literature circle **526** on inquiry card.

Thermometers and Nations

Galileo is credited with the invention of the thermometer in 1590 . . . Fahrenheit's temperature scale was the first rational scale . . . Celsius proposed the Centigrade scale, using 100 degrees between the freezing and boiling points of water . . . Reaumur produced a scale using 80 degrees between the freezing and boiling points of water.

The German Fahrenheit scale is part of the English system of measures, the Swedish Centigrade or Celsius scale became part of the French metric system, and the French Reaumur scale came into general use in Germany and Russia and is still in use by German brewers. (*From ISA, Wayne County Section "Feedback"*)

Extremely Versatile — serves as air filter gage, static pressure indicator, draft gage, air velocity meter, etc.

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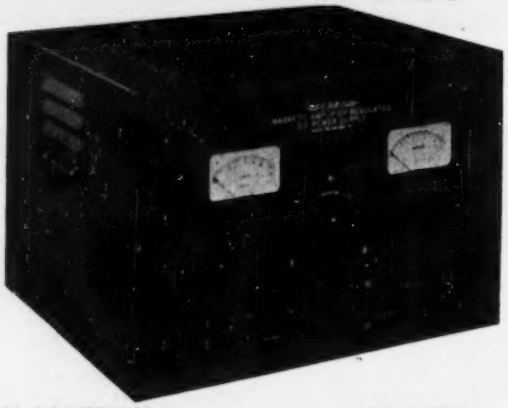
POWER SUPPLIES



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Regulated, Stabilized & Filtered to 1%

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M293	10-32	50	115-5WX	115	5

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BRIEFS—CONTINUED

Electroplating with Rhodium

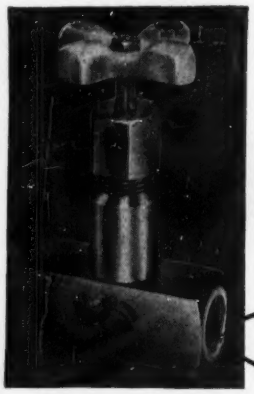
The properties of Rhodium are particularly well-suited to many electrical and electronic applications. In general, Rhodium improves efficiency whenever a low-resistance, long-wearing, oxide-free contact is required. Rhodium plate assures low noise level for moving contacts, no oxide rectification, low and stable contact resistance. Rhodium plated slip rings and commutators show negligible wear. The positive action of plated contacts subject to long periods of inactivity emphasizes the efficiency of Rhodium for safety alarm contacts. Excellent protection against atmospheric corrosion is obtained for printed circuits by plating Rhodium over nickel to assure long wear and low noise, or Rhodium over Silver to provide protection against tarnish and corrosion. (*From new 24-page Form 4381—Electroplating with Rhodium—of Baker & Co., 113 Astor St., Newark, N. J.*

For literature circle **527** on inquiry card.

Magnetic Tape Duplicator

REDWOOD CITY, CALIF.—To demonstrate that high-speed duplication of prerecorded magnetic tapes is as practical and economical as pressing disc records, the Ampex Corporation will feature its tape duplicating equipment at the Los Angeles Audio Fair in the Alexandria Hotel, February 4, 5 and 6. A 1200-foot tape, containing as much as two hours of program material, can be copied with complete fidelity in four minutes.

For literature circle **528** on inquiry card.



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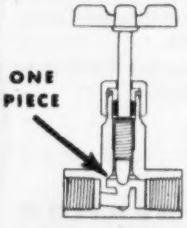

Ask for new Needle Valve Catalog

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Dept. 42, Skokie, Ill.

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Book Reviews

TRANSDUCERS

Compiled by D. B. Kret

Allen B. DuMont Laboratories, Inc., Instrument Div., 760 Bloomfield Ave., Clifton, N. J., 1953. Paper, 152 pages, $2.00.

Compilation of information on commercially available transducers, primarily useful in oscillography, includes tabular listings. Sections on vibration and shock, pressure, temperature, strain, geiger-muller tubes, scintilation and proportional counters, ionization chambers, light, potentiometers, and accessories.

HANDBOOK OF COLORIMETRIC CHEMICAL ANALYTICAL METHODS

Tintometer Limited, England

T. G. Walshe, Box 345, Oyster Bay, L. I., N. Y. 1953 (2nd edition). Leather, 220 pages, $5.00.

Seven chapters, technical, cover general description of Lovibond comparators, applications to pH, chemical analysis, grading tests, clinical analysis, toxic gas analysis, and chemical and grading analysis with Nessleriser—a color comparator for nearly colorless liquids.

FUNDAMENTALS OF THERMOMETRY

J. A. Hall

Institute of Physics, 47 Belgrave Square, London, S. W. 1, England, 1953. Paper, 48-pages, $.70.

Six chapters, undergraduate level, present basic principles and different systems of temperature measurement. One of a series of small "Monographs for Students."

DATA FOR X-RAY ANALYSIS, VOL. I

W. Parrish and B. W. Irwin

Philips Technical Library, Elsevier Press Inc., 402 Lovett Blvd., Houston, Texas, 1953. Paper, 100 pages, $2.00

Eighty-five charts for the solution of Bragg's equation for rapid identification of routine powder analysis covers molybdenum K, copper K, cobalt K, iron K and chromium K.

THE SCIENCE OF PRECISION MEASUREMENT

DoAll Company, Des Plaines, Ill., 1953. Cloth, 264 pages, $3.50

Ten chapters, essentially nonmathematical, give history, development, applications, charts and statistics on "dimensional quality control" by use of gage blocks, sine bars, comparators, etc. Includes history, terminology, tables.

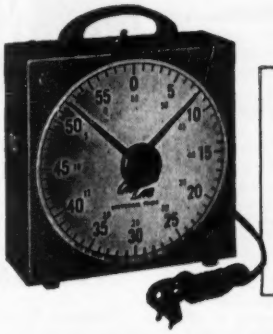
DISPLACEMENT GAS METERS, HANDBOOK E-4

Edited by John C. Diehl

American Meter Co., Publication Dept., Erie, Pa., 1952. Cloth, 276 pages, $4.50

Fifteen chapters treat all phases of displacement meters from fundamental principles of gas measurement to proving, maintenance, and repair of tinned steelcase and iron-case meters.

GRA-LAB THE ALL PURPOSE LABORATORY TIMER



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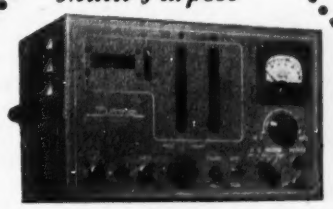

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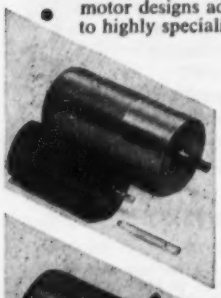

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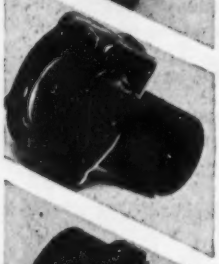
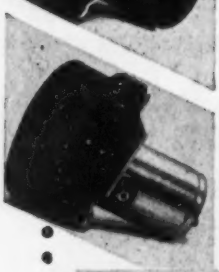


400 cps, 115 VAC 1 Ø motor and L-R #2 Centrifugal Blower. 22 CFM free air. With 60 cps motor, 10 CFM. With 28 VDC motor, 33 CFM.



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MANUFACTURERS' NEW LITERATURE

In this department we report new literature, pertaining to instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free ORDER Card on Page 177.

Requests for literature FROM ABROAD should be made on company letterhead and mailed DIRECTLY to the manufacturers.

PROCESS CONTROL

Process Instrumentation. New 48-page issue Vol. 7, No. 1 of "Instrumentation" presents articles on heat treating control of aluminum alloys for jet planes, open-hearth flow controllers for gaseous and liquid fuel, quality control for distillery, a completely automatic refinery, and other articles on process control.—Industrial Div., Minneapolis Honeywell Regulator Co., Phila. 44, Pa.

Circle **529** on inquiry card.

Remote Controller-index Setting. New illustrated 4-page Bulletin 8930 on "Fixed and Adjustable Indexet Mechanisms" describes construction, operation, and applications of these pneumatic remote index-setting devices. Includes typical applications in processes with lags and variable control-medium quality.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **530** on inquiry card.

Power Position Relay. New 4-page illustrated Bulletin 473 gives characteristics, performance record, operation, features and specifications of maker's relay "Poweractor" positioner with 20,000-lb. force.—Foxboro Co., Foxboro, Mass.

Circle **531** on inquiry card.

Furnace Control. New 48-page illustrated Bulletin P1260 gives description and specifications of maker's large and comprehensive line of control instruments for furnaces, ovens, dryers and kilns, including pyrometers, thermometers, control valves.—Bristol Co., Waterbury, Conn.

Circle **532** on inquiry card.

Annunciator Alarm Systems. New 2-page illustrated bulletin gives features and wiring diagram of maker's new single-relay annunciator alarm systems.—SCAM Instrument Corp., 3909 W. Irving Park, Chicago, Ill.

Circle **533** on inquiry card.

Furnace Control. New 4-page illustrated issue Vol. 13, No. 4 of "Wheelco Comments" presents articles on close control carburizing in commercial steel treating and bakery oven controls.—Barber-Colman Co., Rockford, Ill.

Circle **534** on inquiry card.

Combustion Control. New 4-page illustrated Bulletin SA-11-50 presents features, general description of component parts and operating principle of maker's "Type SA Robot-Eye" combustion control for oil burners.—Standard Instrument Corp., 350 Fifth Ave., New York, N. Y.

Circle **535** on inquiry card.

Hot-water Control. New 8-page illustrated Bulletin F6167 gives features, operating procedure and components of maker's electronic hot water controls in heating systems, including adjustable ratio outdoor reset.—Barber-Colman Co., Rockford, Ill.

Circle **536** on inquiry card.

Multi-point Recorder-Controllers. New 4-page illustrated Bulletin F-452M gives components, operating principle, features and specifications of maker's multi-point recorder-controller that features "segmental" chart drive to give 24, 48, or 96 points.—Fielden Instrument Div., 2920 N. Fourth St., Phila., Pa.

Circle **537** on inquiry card.

Process Automation. New 1-page bulletin presents schematic diagram of maker's instruments integrated into complete process automatic control by use of "robot interlock" system.—Technifiex Corp., Instrument Div., Port Jervis, N. Y.

Circle **538** on inquiry card.

Combustion Control. New 4-page illustrated Bulletin C-101 presents features of maker's automatic combustion controls, including master regulators, air flow regulators, draft regulators, etc.—Reliance Instrument Mfg. Corp., 190 Glen Cove Ave., Glen Cove, L. I., N. Y.

Circle **539** on inquiry card.

Process Instruments. New 8-page illustrated Bulletin F-5910 describes facilities, services and products of maker, including aircraft controls, textile machinery, metal cutting and machine tools, small motors, automatic air conditioning controls, and combustion-safeguard equipment. Includes positioning controls, relays, etc.—Barber-Colman Co., Rockford, Ill.

Circle **540** on inquiry card.

Instrument and Control Boards. New 8-page illustrated Bulletin 700 de-

scribes maker's control and instrument boards and manufacturing facilities.—Continental Electrical Equipment Co., Box 1055, Cincinnati, Ohio.

Circle **541** on inquiry card.

Servomechanisms. New 24-page illustrated Bulletin S-1 presents "New Concepts in Servomechanism Design and Analysis" including analog computers for servo problems, electromechanical lead networks for a-c. servo mechanisms, and stabilizing servomechanisms.—Cook Electric Co., 2700 Southport Ave., Chicago, Ill.

Circle **542** on inquiry card.

VALVES

Automatic Shut-off Valves. New 2-page illustrated bulletin gives features, specifications, and operation of maker's "Series S-214" automatic shut-off valves for protection of gauges and instruments against overloads.—Sprague Engineering & Sales Corp., 1144 W. 135 St., Gardena, Calif

Circle **543** on inquiry card.

Valves, Strainers, Driers. New 16-page illustrated Catalog 101 covers maker's diaphragm packless valves, shut-off valves, hand expansion valves, liquid-level gages, relief valves, driers, strainers, and filters.—Henry Valve Co., 3215 North Ave., Melrose Park, Ill.

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Ball Valves. New 22-page illustrated Catalog V-25M-4-53 gives features, applications, and specifications of maker's ball valves.—Rockwood Sprinkler Co., 38 Harlow St., Worcester, Mass.

Circle **545** on inquiry card.

Relief Valves. New 4-page illustrated Bulletin AD gives features, dimensions, and schematic cross-sectional diagram of maker's cartridge-type hydraulic pilot-operated relief valve.—Pantex Mfg. Corp., Pawtucket, R. I.

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"Wobble-rod" Air Valve. New 8-page illustrated Bulletin 61861 presents specifications, features, applications and prices of maker's new wobble-rod air valve whose lever is swiveled.—Pantex Mfg. Corp., P.O. Box 660, Pawtucket, R. I.

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Hydraulic Servo Valves. New 4-page illustrated Bulletin 500 gives application, design, typical specifications, and schematic diagram of maker's "Series 500" electro-hydraulic four-way servo valves in which 8-ma. current controls hydraulic servo output.—Moog Valve Co., Inc., Proner Airport, E. Aurora, N. Y.

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Temperature Control Valve. New 2-page Bulletin F-80 gives features and dimensional diagram of maker's self-operated temperature control valve with sliding gate.—Jordan Regulator Corp., 1609 Carew Tower, Cincinnati, Ohio.

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Pressure-reducing Valve. New 4-page Bulletin F-160 presents features, weight, dimensions and pressure rating of maker's pressure-reducing valve with patented sliding gate.—Jordan Regulator Co., 1609 Carew Tower, Cincinnati, Ohio.

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TEMPERATURE

Thermocouple Calibration Data. New 12-page Bulletin P1259 has 8 pages of tables based on data recently released by The National Bureau of Standards, adopted by SAMA and ISA, and corrected to the absolute volt and to the International Temperature Scale of 1948. Also described are maker's program controllers and potentiometer pyrometers.—The Bristol Co., Waterbury, Conn.

Circle **551** on inquiry card.

Temperature Conversion Table. New temperature conversion chart gives Centigrade and Fahrenheit conversions.—Moeller Instrument Co., 132nd and 89th Sts., Richmond Hill, N. Y.

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Temperature Control Systems. New 8-page illustrated Bulletin F-6149 gives control terminology, considerations for sensing-element choice and placement, rules for proper temperature control, and types and applications of maker's control systems. Includes data for matching control to process characteristics.—Wheelco Instrument Div., Barber-Colman Co., Rockford, Ill.

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Bimetal Thermostats. New 2-page illustrated Bulletin F-2009 gives operating principle, schematic diagram, ratings, and typical performance of maker's "Type M" bimetal-disk thermostats.—Stevens Mfg. Co., Inc., Mansfield, Ohio.

Circle **554** on inquiry card.

Pyrometer Converters. New 4-page bulletin describes kits for converting mechanical potentiometer pyrometers to electronic operation.—Pyrometer Service Co., 348 River Rd., N. Arlington, N. J.

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Pyrometers. New 8-page illustrated Catalog 85 gives technical data on

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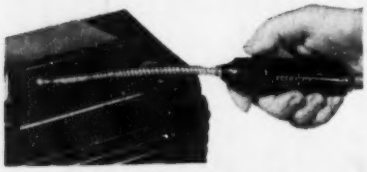

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MANUFACTURERS' NEW LITERATURE

principles of optical pyrometry, applications, and description of maker's "Pyro" optical pyrometer.—Pyrometer Instrument Co., Inc., Bergenfield, N. J.

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Fire Detection. New 2-page illustrated issue No. 5 of "Instrument News" features articles on aircraft fire protection, glow plug progress report, thermostats for lab analysis, and resistance temperature detection.—Thomas A. Edison Inc., Instrument Div., West Orange, N. J.

Circle **557** on inquiry card.

Test Cabinets. New 2-page illustrated Bulletin 103-102 gives features and specifications of maker's "Module" cabinet for testing from −100 to 40 deg. F.—Hudson Bay Div., Refrigeration Systems, Inc., 646 W. Washington Blvd., Chicago, Ill.

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PRESSURE

Miniature Pressure-operated Potentiometers. New 4-page illustrated Brochure 3553 describes new miniature pressure-actuated potentiometers, giving specifications, diagrams, curves, charts, etc.—Bourns Laboratories, 6135 Magnolia Ave., Riverside, Calif.

Circle **559** on inquiry card.

Pressure Pickup. New illustrated Bulletin 1534A gives features, specifications, and dimensional drawings of maker's flush-diaphragm "Type 4-310" pressure pickup.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle **560** on inquiry card.

Static Pressure Controls. New 1-page illustrated Catalog 104 gives description, operation, and specifications of maker's static pressure switch.—Henry G. Dietz Co., 12-16 Astoria Blvd., Long Island City 2, N. Y.

Circle **561** on inquiry card.

Vacuum Gage. New 1-page bulletin gives features, operation, and electrical data of maker's Philips "PHG-09" vacuum gauge for range between 0.5 to 10^{-7} mm. Hg.—Consolidated Vacuum Corp., Rochester 3, N. Y.

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Expansion Bellows. New 6-page illustrated Bulletin 300 gives features, applications and specifications of maker's metal expansion bellows for conveying gas and liquids.—Titeflex, Inc., 500 Freylinghuysen Ave., Newark, N. J.

Circle **563** on inquiry card.

High-vacuum Equipment. New 114-page illustrated Catalog 13-K covers maker-distributor's lines of high-vacuum pumps, oils, diffusion pumps, evaporators, glass blowing equipment, ovens, furnaces, etc.—Research Vacuum Supply Co., 3434 W. Montrose Ave., Chicago, Ill.

Circle **564** on inquiry card.

Differential-pressure Transmitter. New 4-page illustrated Bulletin A-707-A gives principles of operation, description and dimensional diagrams of maker's new "Autronic" differential-pressure transmitter.—Swartwout Co., 18511 Euclid Ave., Cleveland, Ohio.

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Pressure, Flow. New 4-page illustrated bulletin features description and ranges of maker's gages for measuring combustion, draft, pressure, flow, vacuum, carbon dioxide, smoke, velocity, static pressure, pressure differential and temperature.—F. W. Dwyer Mfg. Co., 317 S. Western Ave., Chicago, Ill.

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FLOW

Controlled Volume Pumps. New 16-page illustrated Bulletin 1053 gives principle of operation, capacity adjustment, typical applications, design, dimensions and types of maker's air-powered controlled-volume pumps.—Milton Roy Co., 1300 E. Mermaid Lane, Phila., Pa.

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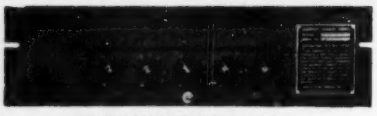
Chemical Feed Pump. New 4-page illustrated Bulletin PM 20 gives de-



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scription, performance, installation, general applications and specifications of maker's "Model S" heavy-duty positive-displacement diaphragm-type chemical-solution feed pump.—Precision Machine Co., 8 Walnut St., Somerville, Mass.

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Level, Air-Flow Control. New 16-page illustrated booklet presents applications, installation advice, principle of operation, specifications, performance, operation, and electrical characteristics of maker's "Detect-A-Flo" unit that uses thermal-switch device to detect and control liquid level and air flow.—Fenwal, Inc., Ashland, Mass.

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Float Trap. New 4-page illustrated Bulletin Section 1 gives description, applications and dimensional drawing of maker's twin seal check valve for draining corrosive liquids.—V. D. Anderson Co., 1935 W. 96 St., Cleveland, Ohio.

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WEIGHT

Multiple Filling Equipment. New 2-page illustrated bulletin gives features, operation and accessories of distributor's "Filamatic" vial fillers for rapid filling operations.—Scientific Glass Apparatus Co., Inc., 100 Lakewood Terrace, Bloomfield, N. J.

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Weigh-Feeder. New 4-page bulletin lists features and applications for maker's "Injecto-Weigh" for weigh-feeding of plastics.—Glengarry Equipment Corp., Bay Shore, N. Y.

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Precision Weighing. New 6-page illustrated bulletin gives features, specifications and types of maker's electronic "Metrogram" precision weighing instrument that uses balance principle with capacitive-type electronic-bridge indication.—H. A. Hadley Assoc., Inc., Winooski, Vt.

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LAB APPARATUS

Chemical Balances. New 4-page Bulletin 329 gives descriptions and features of distributor's precision balances, including automatic loading aperiodic balance with immediate totaling of weights, aperiodic projected reading balance, rapid weighing balance, and micro-chemical aperiodic, projected reading balance.—Burrell Corp., 2223 Fifth Ave., Pittsburgh, Pa.

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Electron Microscope. New 4-page bulletin gives applications and design and operating information on electron microscope, including viewing screen, accelerating potential, magnification, electron diffraction, focus determination, control, etc.—North American Philips Co., Inc., Mt. Vernon, N. Y.

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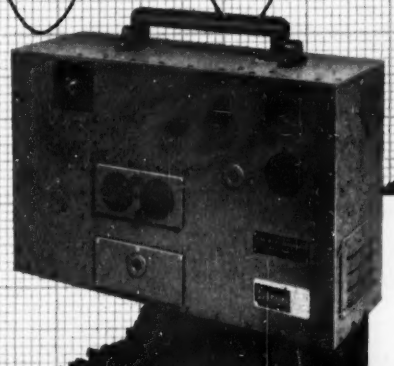

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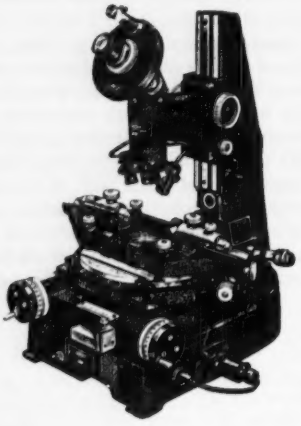

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NEW LITERATURE

Laboratory Apparatus. New 12-page illustrated Catalog 3350 presents distributor's instruments and laboratory apparatus, including pH meters, spectrometers, spectrographs, electron microscopes, Leitz dilatometers, metallographs, centrifuges, etc.—Harshaw Scientific Div., Harshaw Chemical Co., Cleveland 6, Ohio.
Circle **576** on inquiry card.

Laboratory Apparatus. New 24-page issue No. 19 of "What's New for the Laboratory" features new line of heating mantles with aluminum housings, two new ovens, sterile fluid pump, glass fraction cutter, chromatography equipment, etc.—Scientific Glass Apparatus Co., Inc., Bloomfield, N. J.
Circle **577** on inquiry card.

Melting-point Apparatus. New 2-page illustrated Bulletin 13 presents features, construction, operation and description of maker's reflected light "Melt-Meter" macro-type melting-point apparatus.—National Instrument Co., 5005 Queensbury Ave., Baltimore, Md.
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Freeze-drying Apparatus. New 2-page illustrated bulletin describes maker's all-glass and stainless-steel freeze-drying apparatus.—E. Machlett & Son, 220 E. 23 St., New York, N. Y.
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Water Demineralizers. New 4-page illustrated Bulletin 126 gives operating procedure, description, principle of operation and list of users of maker's mixed-bed water demineralizers.—Barnstead Still & Sterilizer Co., 2 Lanesville Terrace, Forest Hills, Boston, Mass.
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Water Distillation. New 1-page bulletin gives features and analysis of water made from maker's "American" water still for applications requiring high-purity pyrogen-free distilled water.—American Sterilizer Co., Erie, Pa.
Circle **581** on inquiry card.

Laboratory Apparatus. New 8-page Dec. 1953 issue of "Digest" lists lab equipment, foreign and domestic, including portable refrigeration system, Todd Spectranal, stirrers, slides and tubing.—A. Daigger & Co., 159 W. Kinzie St., Chicago 10, Ill.
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Laboratory Ware. New 1-page bulletin presents shapes available in polyethylene laboratory ware for industrial installations.—Bel-Art Products, 2209 Central Ave., Union City, N. J.
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Vacuum Balance. New 1-page Bulletin CB/18 presents features, operation and specifications of distributor's Sartorius vacuum balance for weighing up to 200 grams in vacuum with sensi-

tivity of 0.1 mg.—C. A. Brinkmann & Co., 378 Great Neck Rd., Great Neck, N. Y.

Circle **584** on inquiry card.

Laboratory Equipment. New 12-page illustrated Catalog SD-2 lists and describes maker's laboratory equipment such as fume hoods, center and wall tables, cabinets, etc.—Metalab Equipment Corp., 214 Duffy Ave., Hicksville, L. I., N. Y.

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Lab Homogenizer. New 2-page illustrated Bulletin 9/53 presents features, uses and accessories of maker's micro and macro laboratory homogenizer with variable speeds to 27,000 rpm.—E. Machlett & Son, 220 E. 23 St., New York, N. Y.

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ANALYTICAL

Hydrogen Analyzer. New 4-page illustrated Bulletin 301 gives features and operation of maker's hydrogen analyzer for continuous analysis, control, and recording of molecular hydrogen.—Taller & Cooper, Inc., 75 Front St., Brooklyn 1, N. Y.

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Spectrograph. New 6-page reprint is article on the spectrograph in modern industry. Includes principles, techniques, and typical applications.—Jarrell-Ash Co., Newtonville, Mass.

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Automatic Spectrophotometry. New 4-page illustrated Bulletin R-58 gives recent advancements in automatic spectrophotometry—an automatic robot spectrophotometer with recorder servo-controlled by wavelength-drive unit.—Beckman Div., Beckman Instruments Inc., S. Pasadena, Calif.

Circle **589** on inquiry card.

Thermal-conductivity Gas Analysis. New 4-page Bulletin TC-953 presents features, applications and specifications of maker's "EverTite" thermal-conductivity units for economic gas analysis.—Gow-Mac Instrument Co., 100 Kings Rd., Madison, N. J.

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PPM Gas Analyzer. New 2-page illustrated bulletin describes modifications of maker's "Model 21" infrared gas analyzer with sensitivity to 1/3 ppm. for CO and CO_2.—Liston-Becker Instrument Co., Inc., P.O. Box 628, Springdale, Conn.

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Carbon-dioxide Indicator. New 4-page illustrated bulletin gives features, operation, and uses of maker's portable "Thermco Analyzer" carbon-dioxide indicator.—Instrument Engineering Service, Johnson Rd., Michigan City, Ind.

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X-ray "Quantometer." New 2-page illustrated issue, Vol. 2, No. 11 of "ARLife" describes maker's new X-ray-fluorescence "Quantometer" for chemical analysis of metals, powders,

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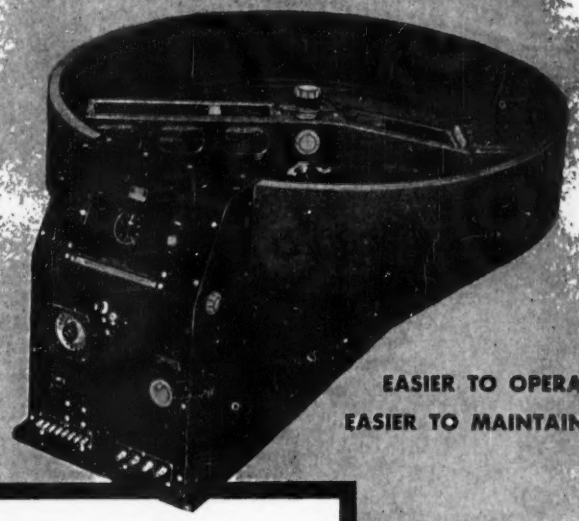

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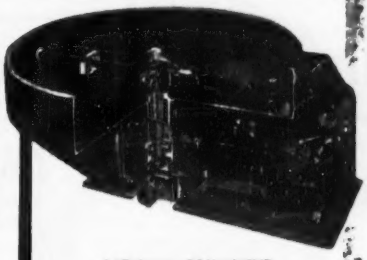

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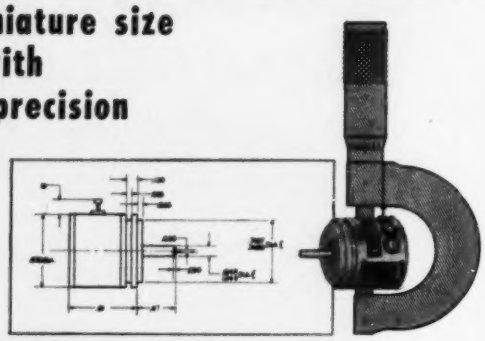

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NEW LITERATURE

and liquids.—Applied Research Labs., P.O. Box 1710, Glendale, Calif.
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Gas Analyzers. New 4-page illustrated Bulletin GMH-853 gives features and applications and typical deflection values of maker's "Gas Master" relative thermal-conductivity instrument for measuring and analyzing gases.—Gow-Mac Instrument Co., 100 Kings Rd., Madison, N. J.
Circle **594** on inquiry card.

Gasometric Analyses. New 2-page illustrated bulletin gives description and principle of operation in diagram of maker's "Gasometer" for analysis of blood or liquids for CO_2 combining power, oxygen capacity, etc.—Micrometric Instrument Co., P.O. Box 884, Cleveland 22, Ohio.
Circle **595** on inquiry card.

OPTICAL

Telescopes, Microscopes. New 12-page bulletin lists scientific hobby gifts, including telescopes, microscopes, binoculars, hand warmers, alarm wrist watches, telespecs, barometers, scientific books and toys, magnifiers, lens kits and spectroscopes. —Edmund Scientific Corp., 101 E. Gloucester Pike, Barrington, N. J.
Circle **596** on inquiry card.

Electron-microscope Camera. New Catalog sheet EM.418 gives features and specifications of maker's roll-film camera "MI-12912" supplementing plate camera in electron microscopes. —Radio Corp. of America, Camden, N. J.
Circle **597** on inquiry card.

Cast Optics. New 12-page illustrated bulletin gives characteristics and fabrication data of maker's optically-clear rigid plastic sheets. Table of comparative properties included.—Cast Optics Corp., Riverside, Conn.
Circle **598** on inquiry card.

Oscillogram Processor. New 6-page Bulletin 23-109 gives features, operation, construction and specifications of maker's automatic oscillogram processor "Type 23-109" which can process oscillograph paper at speeds of 12 ft. per minute.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.
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Color Comparator. New 2-page illustrated bulletin gives features and description of maker's new "Model C Color-Eye" color comparator.—Instrument Development Labs., Inc., 163 Highland Ave., Needham Hts., Mass.
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Photoelectric Relays. New Bulletins GEA-5920 and GEA-5921 give descriptions, operation, application data and accessories for maker's photoelectric relay CR7505-K201-K202 which gives up to 450 operations per minute, and

CR7505-N210,-211 giving up to 600 operations per minute.—General Electric Co., Schenectady 5, N.Y.

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Photographic Copying. New 6-page illustrated bulletin presents features and equipment for making photocopies in one minute by maker's new dry process.—Dri-Stat Div., Peerless Photo Products, Inc., Shoreham, L.I., N. Y.

Circle **602** on inquiry card.

Microphotometer Attachment. New 2-page illustrated Bulletin 12 presents features, uses and description of maker's "Microphot Ocular" for converting standard microscope into precision microphotometer for light absorption measurements.—National Instrument Co., 5005 Queensbury Ave., Baltimore, Md.

Circle **603** on inquiry card.

Photometer. New 4-page Bulletin 53 gives features, general description, and technical information on maker's ultrasonic electron-multiplier photometer.—Ultrasonic Engineering Co., P.O. Box 46, Maywood, Ill.

Circle **604** on inquiry card.

RECORDING

Oscillography. New 8-page illustrated issue Vol. 1, No. 2 of "The Right Angle" presents articles on factors affecting accuracy of oscillographic records, effects of controls on stylus position, and electronic switch permitting sampling of three input signals in one channel.—Sanborn Co., Cambridge 39, Mass.

Circle **605** on inquiry card.

Recording Oscillograph. New 12-page illustrated Bulletin GEC-449B gives features, operation, application and accessories of maker's general-purpose 6-channel oscillograph.—General Electric Co., Schenectady 5, N. Y.

Circle **606** on inquiry card.

Multi-channel Amplifier. New 16-page illustrated Bulletin 1403C gives description, operating principles, specifications, and electrical and physical details of maker's unitized multi-channel amplifier "System D" for static and dynamic measurements with either self-generating or excited pickups.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle **607** on inquiry card.

Oscillograph Recording. New 8-page issue Vol. 1, No. 1 of "The Right Angle" features articles on factors affecting accuracy of oscillograph records, use of differential transformers with strain gage amplifiers, and use of intermediate networks.—Sanborn Co., Industrial Div., Cambridge 39, Mass.

Circle **608** on inquiry card.

Oscillograph Control Unit. New 2-page illustrated bulletin gives general specifications, description and operation of maker's mobile oscillograph

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control unit.—Omni Engineering Inc., Washington, D. C.

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MOISTURE

Moisture Meters. New 1-page and 4-page bulletins give features, operations and applications of maker's "G-5 Moisture Register" for granular, ground, loose, shredded and powdered materials, and lumber moisture register.—Electronic Moisture Register, 1510 W. Chestnut St., Alhambra, Calif.

Circle **610** on inquiry card.

Moisture Measurement. New 6-page illustrated bulletin presents excerpts from lecture on measuring of water content in continuous fibrous sheets.—Hygrotester Inc., P.O. Box 923, Brooklyn 1, N. Y.

Circle **611** on inquiry card.

SURFACE

Surface Roughness. New 4-page bulletin describes and illustrates maker's "Profilometer Type QA Amplimeter for surface-roughness measurement.—Micrometrical Mfg. Co., Ann Arbor, Mich.

Circle **612** on inquiry card.

Surface Finish Control. New 8-page ED-21703-25M gives ways in which surface finish control can reduce machine costs, increase production capacity, and improve product with maker's "Surfindicator."—Brush Electronics Co., 3405 Perkins Ave., Cleveland, Ohio.

Circle **613** on inquiry card.

Surface Control. New 8-page illustrated bulletin gives characteristics of waviness on surfaces of rotation, method of measurement and control, and operation of maker's "Wavometer."—Micrometrical Mfg. Co., 345 S. Main St., Ann Arbor, Mich.

Circle **614** on inquiry card.

Toolmakers' Flat. New 6-page illustrated bulletin presents applications and features of maker's black granite toolmakers' flats.—Collins Microflat Co., 2326 E. 8 St., Los Angeles, Calif.

Circle **615** on inquiry card.

INSPECTION, GAGING

Textile Uniformity Analyzer. New 4-page illustrated Bulletin ED-21401 8-53-3M presents description, features, and operation of maker's yarn, roving, and sliver uniformity analyzer.—Brush Electronics Co., 3405 Perkins Ave., Cleveland, Ohio.

Circle **616** on inquiry card.

Capacitance Proximity Gage. New 2-page illustrated Bulletin F-951 presents features, operation, applications and technical data for maker's proximity meter capacitance gage capable of measuring dimensions and distortions without physical contact with object.—Fielden Instrument Div., 2920 N. Fourth St., Phila., Pa.

Circle **617** on inquiry card.

Non-destructive Testing. New 12-page illustrated issue Vol. 1, No. 1 of "Magnafacts" presents practical applications of nondestructive testing methods.—Magnaflux Corp., 7300 W. Lawrence Ave., Chicago 31, Ill.

Circle **618** on inquiry card.

Non-destructive Testing Instruments. New 8-page illustrated Bulletin 32 gives applications of maker's nondestructive testing machines to sorting, measuring, detection, inspection, and control. Includes metallurgical "Cyclograph," ultrasonic "Metroscope," electronic micrometers, etc.—J. W. Dice Co., Englewood, N. J.

Circle **619** on Inquiry card.

Internal Comparators. New 16-page illustrated Bulletin 567 gives applications, features and specifications of maker's "Electrolimit" internal comparators for gaging internal diameters.—Pratt & Whitney, W. Hartford 1, Conn.

Circle **620** on inquiry card.

Rockwell Hardness. New pocket chart gives corrections for rockwell hardness tester reading to be added for cylindrical work.—Wilson Mechanical Instruments Div., American Chain & Cable Co., Inc., 230 Park Ave., New York, N. Y.

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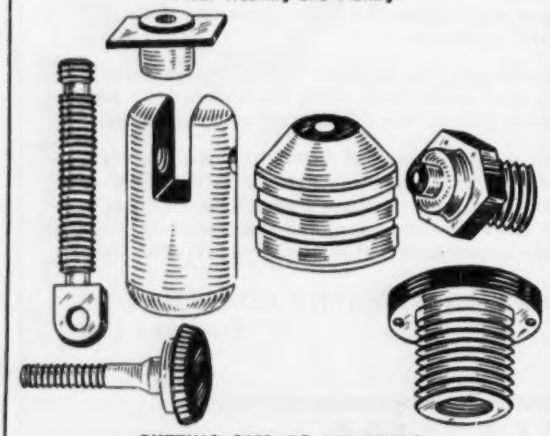

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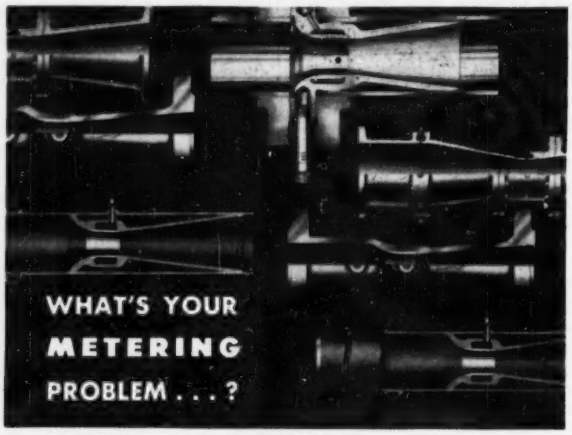

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TIMING, COUNTING

Timing Motors, Clocks. New Engineering Bulletins 1, 2, 3, and 4, and 8-page Catalogs 322, 323, 324 give features, applications and principles of design of maker's elapsed-time indicators, trigger-trip time-delay relays, cycle timing units, timing motors, and timing clock movements.—Havdon Mfg. Co., Inc., 245 E. Elm St., Torrington, Conn.

Circle **622** on inquiry card.

Magnetic Impulse Counter. New 4-page illustrated bulletin gives features and operating characteristics of maker's magnetic selector-switch-type impulse counter for control and switching problems.—Kellogg Switchboard and Supply Co., 79 W. Monroe St., Chicago, Ill.

Circle **623** on inquiry card.

Alarm Wrist Watch. New 2-page Bulletin gives features and applications of importers wrist watch with built-in alarm.—Edmund Scientific Corp., 101 E. Gloucester Pike, Barrington, N. J.

Circle **624** on inquiry card.

Time Interval Measurements. New 4-page issue (Vol. 5, No. 1-2) of "hp Journal" describes method of measuring time intervals with maker's electronic counter.—Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.

Circle **625** on inquiry card.

Oscillation and Rotation Timers. New 2-page Bulletins I-1 and I-18 give operating instructions for maker's "Labmarker" which produces time markings on oscilloscope tracings and for maker's "Labstrobe, Model 18" which generates 60 flashes of light per second and is used to time objects rotating at multiples of 60.—Berkshire Labs., Lincoln, Mass.

Circle **626** on inquiry card.

Electronic Timer. New 1-page illustrated bulletin gives description and specifications of maker's electronic timer for use in viscosity measurements, etc.—Hallikainen Instruments, 1341 Seventh St., Berkeley, Calif.

Circle **627** on inquiry card.

Decade Scaler. New 4-page illustrated technical bulletin presents features and specifications of maker's new 30-kc. decade scaler with glow-transfer counter tubes and decade stages.—North American Philips Co., Inc., Mt. Vernon, N. Y.

Circle **628** on inquiry card.

VIBRATION, ACCELERATION

Balancing Machines. New 4-page illustrated bulletin gives principles, features and photograph explaining operation of maker's new dynamic balancing machine.—Welch Mfg. Co., 920 W. Laurel St., Springfield, Ill.

Circle **629** on inquiry card.

Accelerometers. New Bulletins A 314, A 320, A 410 and A 105 give

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characteristics and specifications of maker's regular and subminiature accelerometers.—Gulton Mfg. Corp., Metuchen, N. J.

Circle **630** on inquiry card.

Accelerometer Test Set. New 1-page illustrated Bulletin KA-1A gives features and specifications of maker's "Model KA-1 Test Set" with lightweight accelerometers.—Gulton Mfg. Corp., Metuchen, N. J.

Circle **631** on inquiry card.

Bearing Vibration. New 4-page illustrated bulletin gives operation and construction of maker's "Anderometer," an instrument for testing assembled ball bearings for vibration. Also describes unit of measurement.—the "Anderon."—Micrometrical Mfg. Co., 345 S. Main St., Ann Arbor, Mich.

Circle **632** on inquiry card.

Self-generating Accelerometers. New 54-page catalog presents articles on barium-titanate crystals as accelerometer elements, and characteristics of maker's self-generating "Glennite" accelerometers.—Gulton Mfg. Corp., Metuchen, N. J.

Circle **633** on inquiry card.

Vector Nomograph. New 2-page bulletin gives calibration tables, suggestions for use, and vector nomograph for use with maker's "Impact-O-Graph." Vector nomograph gives both impact measurement and direction of force.—Impact-O-Graph Corp., Cleveland, Ohio.

Circle **634** on inquiry card.

Ballistic Pendulum. New 2-page illustrated bulletin presents features, specifications and operating characteristics of maker's "Model AT-2" ballistic pendulum.—Gulton Mfg. Corp., Metuchen, N. J.

Circle **635** on inquiry card.

Vibration, Deflection Measurement. New 2-page illustrated Bulletin 30.2.53J presents features, technical data and applications of distributor's Askania Hand-Vibrograph for measuring vibration of machinery, structures, etc.—EPIC, Inc., 154 Nassau St., New York, N. Y.

Circle **636** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

Tube Tester, Volt-ohm-milliammeter. New 4-page Bulletins TT5A1-105310C and 209A2-15310C list technical specifications and uses of multipurpose "Model 209A" capacitance tester and vacuum-tube volt-ohm-milliammeter and describes 10 dynamic-mutual-conductance tube testers.—Hickok Electrical Instrument Co., 10519 Dupont Ave., Cleveland, Ohio.

Circle **637** on inquiry card.

Indicating Instruments. New 8-page illustrated Bulletin GEC-979A presents applications, features, prices and performance of maker's "Type DP-11 and DP-12" portable d-c indicating instruments.—General Electric, Schenectady 5, N. Y.

Circle **638** on inquiry card.

Ultrasonic Amplifier. New 8-page illustrated issue Vol. 28, No. 6 of "General Radio Experimenter" presents articles on laboratory amplifier for audio and ultrasonic frequencies (3-watt output to 250 kc.) oscillator considerations, and electrolytic capacitor testing at 120 cycles.—General Radio Co., 275 Massachusetts Ave., Cambridge, Mass.

Circle **639** on inquiry card.

Unit Oscillator. New 8-page illustrated issue, Vol. 28, No. 4 of "General Radio Experimenter" gives description, electrical circuit, construction, features, and specifications of maker's unit oscillator for 0.5 to 50 Mc. range, plus index to Vols. 26 and 27.—General Radio Co., 275 Massachusetts Ave., Cambridge, Mass.

Circle **640** on inquiry card.

Meter-relay Circuitry. New 8-page illustrated Bulletin 112 gives operation and features of maker's single-double-contact meter-relay-type control units, including automatic, manual and self-releasing reset, polypoints, plug-ins, etc.—Assembly Products, Inc., Chagrin Falls, Ohio.

Circle **641** on inquiry card.

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Switchboard Instruments. New 24-page illustrated Bulletin GEC-218C gives description, features, dimensions, principles of operation, and technical information of maker's long-scale switchboard instruments.—General Electric Co., Schenectady 5, N. Y.

Circle **642** on inquiry card.

Electronic Test Equipment. New Bulletins (203, TT5A, 292, 7A, 353) give features, specifications and applications of maker's high-frequency circuit and tube testers, such as vacuum-tube volt-ohm-milliammeter, mutual-conductance tube testers, microvolt signal generator, cathode-ray oscilloscope, video generator, alignment generator, RF marker and crystal calibrator, 250-degree panel meters, etc. —Hickok Electrical Instrument Co., 10514 DuPont Ave., Cleveland, Ohio.

Circle **643** on inquiry card.

Microwave Test Equipment. New 8-page illustrated catalog presents descriptions, specifications and prices of maker's line of microwave test equipment.—Nassau Research & Development Associates Inc., 66 Main St., Mineola, N. Y.

Circle **644** on inquiry card.

Computors. New 24-page illustrated reprint "Introduction to Analog Computors" presents history, classification, and basic elements of analog and digital computers, with emphasis on operational-amplifier-type analog computors.—George A. Philbrick Researches, Inc., 230 Congress St., Boston, Mass.

Circle **645** on inquiry card.

Computer Operational Amplifier. New 2-page illustrated Bulletin K2W presents applications, specifications and schematic diagram of maker's "Model K2-W" operational amplifier for analog computing.—George A. Philbrick Researches, Inc., 230 Congress St., Boston, Mass.

Circle **646** on inquiry card.

Dosimeters, Roentgen Meters. New 4-page illustrated Bulletin 6-10 describes maker's direct reading dosimeter, pocket chamber dosimeter, roentgen meter and radiation analysis unit. —Landsverk Electrometer Co., 550 W. Garfield Ave., Glendale, Calif.

Circle **647** on inquiry card.

Power Generator. New 2-page illustrated bulletin gives description, applications, operation and specifications of maker's variable-frequency power generator "Model 1000A" with 500-volt-ampere output over audio spectrum.—Industronics, Arlington Heights, Ill.

Circle **648** on inquiry card.

Frequency Meter. New 1-page illustrated Bulletin 1065-X gives description, specification and features of maker's new "Stroboconn Model 6T-4" stroboscopic-type frequency meter for 32.703 to 4,1866 cps. to an accuracy of 0.05 percent.—C. G. Conn Ltd., Electronics Div., Elkhart, Ind.

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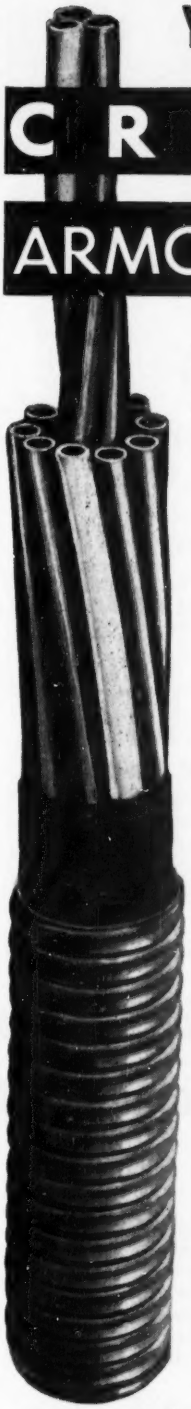

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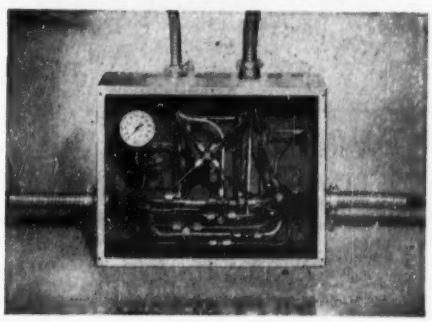

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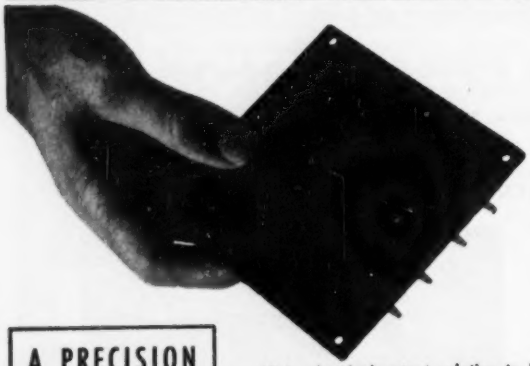

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NEW LITERATURE

SWR Amplifier. New 1-page illustrated Bulletin 35322 gives electrical and mechanical features of maker's "Model TAA-16B" standing-wave-ratio meter with selective frequency response.—Browning Laboratories Inc., Winchester, Mass.

Circle **650** on inquiry card.

Voltage, Amperage Measurement. New 4-page issue Vol. 20, No. 10 of "Electrical Measurements" presents features, operating instructions, and scale ranges of maker's "Universal 88" a-c. d-c. "Polyranger" for measuring voltage and current.—Sensitive Research Instrument Corp., 9-11 Elm Ave., Mt. Vernon, N. Y.

Circle **651** on inquiry card.

Electronic Kits. New 12-page illustrated Catalog 1053-100M gives specifications of maker's kits for vacuum-tube voltmeters, oscilloscopes, tube tester, generators, etc.—Electronic Instrument Co., Inc., 84 Withers St., Brooklyn, N. Y.

Circle **652** on inquiry card.

Synchronizing Generator. New illustrated Bulletin 400-A-1 gives features of maker's synchronizing generator "Model 400-A" for TV.—Dage Electronics Corp., 69 N. Second St., Beech Grove, Ind.

Circle **653** on inquiry card.

Pocket, Panel Indicators. New Bulletins 9-1-50, 9-2-50 in portfolio describe maker's indicating hearing-aid battery-testing meters, panel indicators, and special pocket meters.—Sterling Mfg. Co., 7201 Wentworth Ave., Cleveland, Ohio.

Circle **654** on inquiry card.

High-voltage Tester. New 1-page Bulletin 4-1 gives specifications and description of maker's new "Model 422 Hypot" 10,000-volt portable a-c. test instrument for leakage and breakdown.—Associated Research Inc., 3766 W. Belmont Ave., Chicago, Ill.

Circle **655** on inquiry card.

Multi-waveform Generator. New 2-page illustrated bulletin gives features, specifications and applications of maker's "Syncrogen Model E-10" multi-waveform generator and general purpose pulse synchronization instrument.—Amplitronix Inc., 280 Ninth Ave., New York, N. Y.

Circle **656** on inquiry card.

Microwave Nomograms, Charts. New 20-page booklet "Microwave Nomograms and Charts" describes techniques in use of waveguide components—mixers, duplexers, directional couplers, etc. Includes nomograms on waveguide attenuation, line impedance, cutoff frequency, reactance charts, etc.—Airtron, Inc., Linden, N. J.

Circle **657** on inquiry card.

Electronic Kits. New 40-page 1954 Catalog covers maker's line of test equipment kits, including amplifiers,

signal and laboratory generators, receivers, wattmeters, oscillators, etc.—Heath Co., Benton Harbor, Mich.

Circle **658** on inquiry card.

Ground-resistance Tester. New 8-page Bulletin 1-1 presents theory, application, and methods of soil resistivity measurement. Discusses geophysical prospecting by electrical methods, and gives description and operating characteristics of 8 basic "Vibroground" ground-resistance measuring instruments.—Associated Research, Inc., 3766 W. Belmont Ave., Chicago, Ill.

Circle **659** on inquiry card.

Frequency Meters. New 2-page bulletin gives applications and specifications of "Models FS-C-170 to 174 A" frequency meters.—Frequency Standards, Asbury Park, N. J.

Circle **660** on inquiry card.

Potentiometric Measurements. New 12-page illustrated Bulletin E-18 describes maker's line of portable and laboratory standard potentiometers for precision millivoltage measurements.—Gray Instrument Co., 64 W. Johnson St., Phila., Pa.

Circle **661** on inquiry card.

Resistance Measurement. New 16-page Bulletin E-17 describes maker's standard resistors of Reichsanstalt and Bureau of Standards, plus resistance-measurement instruments of Wheatstone bridge, Kelvin bridge, and Kohlrausch slide-wire types.—Gray Instrument Co., 64 W. Johnson St., Phila., Pa.

Circle **662** on inquiry card.

Electronic Test Equipment. New 12-page illustrated Bulletin 2M-11-53 gives facilities and test equipment of maker, including synchronizer, electronic control amplifier, computer system, junction box, signal data converter, slideback voltmeter, microwave, and impedence reactance test units.—Cal-Tronics, Corp., 11307 Hindry Ave., Los Angeles, Calif.

Circle **663** on inquiry card.

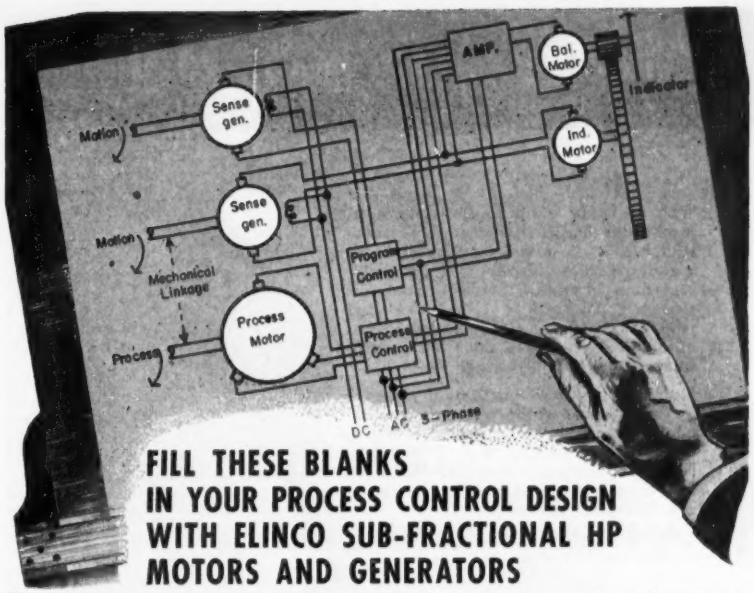
DC Amplifier. New 4-page illustrated bulletin gives characteristics and operating instructions of maker's "Model 55A" stabilized DC amplifier with response from DC to 10 kc., for use with thermocouples, strain gages, etc.—Electro-Mechanical Research, Inc., Ridgefield, Conn.

Circle **664** on inquiry card.

Electronic Instruments. New 12-page Bulletin 108 presents descriptions of maker's electronic measuring instruments including electrometers, relays, oscillators, oscilloscopes, Wheatstone bridges, potentiometers, etc.—Central Scientific Co., 1700 Irving Park Rd., Chicago, Ill.

Circle **665** on inquiry card.

Eddy-current Dynamometer. New 1-page illustrated bulletin gives specifications, features and operation for maker's eddy-current dynamometer for measuring starting torque, drop-



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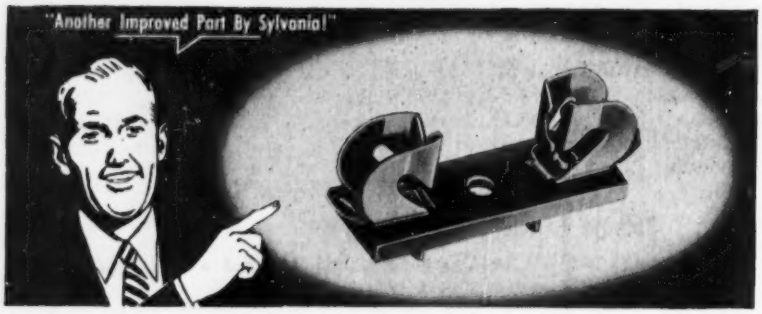

Here's a brand new and an extremely efficient Crystal Diode Holder designed for you by Sylvania. The contacts retain diodes with terminal leads ranging from .078 to .125 diameter, with ease of insertion and withdrawal. The centerline of retention is specially located from the surface of the mounting plate to allow installation of large diameter Crystal Diodes. The mounting plate is made of laminated phenolic and the contacts can be furnished in either phosphor bronze or brass with silver plating. Eyelets are made of nickel plated brass. Write for detailed specification sheets.

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NEW LITERATURE

out torque, speed-torque characteristics, etc.—Magtrol, 533 S. Niagara, Tonawanda, N. Y.

Circle **666** on inquiry card.

UHF Oscillator. New 4-page illustrated bulletin presents specifications, description and application of maker's UHF wide-band power oscillator.—W. L. Maxson Corp., 460 W. 34th St., New York, N. Y.

Circle **667** on inquiry card.

Vibrating-reed Electrometer. New 2-page illustrated bulletin presents design, special features and specifications of distributor's vibrating-reed electrometer and resolved component indicator.—Marconi Instruments Ltd., 23-25 Beaver St., New York, N. Y.

Circle **668** on inquiry card.

Phase Meter, Delay Lines. Four new bulletins present specifications and general description of maker's "Type 205" precision phase detector, "Type 213" high-frequency phase & vector voltage meter, tapped delay lines, and miniature continuously variable delay lines.—Advance Electronics Co., P. O. Box 394, Passaic, N. J.

Circle **669** on inquiry card.

Electronic Test Kits. New 80-page illustrated bulletin features specifications and schematics of maker's electronic test kits including oscilloscopes, generators, transformers, meters, etc. Includes detailed schematics.—Heath Co., Benton Harbor, Mich.

Circle **670** on inquiry card.

Meg-Ohm-Voltmeter. New 1-page Bulletin 640 gives features and specifications of maker's new "Model 640 Meg-Ohm-Voltmeter" for insulation-resistance-continuity and voltage testing.—Hazelton Instrument Co., 128 Liberty St., New York, N. Y.

Circle **671** on inquiry card.

Resonant-reed Oscillator. New 4-page Bulletin 34-10 gives description, construction, circuit, performance, and diagrams of "Frahm" resonant-reed precision oscillators.—James G. Biddle Co., 1316 Arch St., Phila., Pa.

Circle **672** on inquiry card.

POWER SUPPLIES

Power Supplies. New 6-page Bulletin L453A and specifications sheets present features, electrical ratings and types of maker's magnetic-amplifier-regulated d-c power supplies, including models for 5-32 v., 24-32 v., 6000 v., 6 v., 0-12 v., etc.—Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.

Circle **673** on inquiry card.

Power Supply Regulator. New 2-page illustrated bulletin gives general description, applications, and specifications of maker's "Super regulator" 50-microvolt-ripple, 0.005-ohm-output-impedance regulator for use with ordinary power supplies.—Kalb-

fell Labs., Inc., 1090 Moreno Blvd., San Diego, Calif.

Circle **674** on inquiry card.

Transformer-Rectifiers. New 2-page illustrated Bulletin GEC-998 presents application, description, ratings, dimensions and wiring diagrams of maker's airborne transformer-rectifiers for spot d-c. applications in a-c. aircraft electrical systems.—General Electric, Schenectady 5, N. Y.

Circle **675** on inquiry card.

Key Switches, Dry-Disk Rectifiers. New 32-page Catalog covers maker's line of key switches, impulsing devices, switchboard lamps, jacks, plugs, switch rectifiers, etc.—Automatic Electric Sales Corp., 1033 W. Van Buren St., Chicago, Ill.

Circle **676** on inquiry card.

Voltage Calibrators. New 2-page bulletin gives operating principle and specifications for maker's "Models M30B-1 and M30B-1Z" precision voltage calibrators with outputs of 0 to 100 and 0 to 1000 volts.—Kalbfell Labs., San Diego, Calif.

Circle **677** on inquiry card.

RELAYS, SWITCHES

Mercury Switches. New 1-page illustrated Bulletin 90 lists features and specifications of maker's protected mercury switches.—Micro Div., Minneapolis-Honeywell, Freeport, Ill.

Circle **678** on inquiry card.

Time-delay Relays. New 4-page illustrated Bulletin SR3 describes two basic types of maker's pneumatic time-delay relays, one with time delay beginning when coil is energized; one beginning when coil is de-energized. Includes typical applications, dimensions, and wiring diagrams.—A'G'A Div., Elastic Stop Nut Corp. of America, 1027 Newark Ave., Elizabeth, N. J.

Circle **679** on inquiry card.

Relay and Stepping Switch. New 2-page illustrated Bulletin RH 3-15M presents operating characteristics, specifications, and features of maker's shock resistant relay that combines relay and stepping switch functions.—Automatic Electric Sales Corp., 1033 W. Van Buren St., Chicago 7, Ill.

Circle **680** on inquiry card.

Frequency-sensitive Relay. New 8-page illustrated Bulletin 33 gives general description, response, impedance characteristics, mounting, auxiliary relay, dimensions and standard ratings of "Frahm" resonant-reed frequency-sensitive relay.—James G. Biddle Co., 1316 Arch St., Phila., Pa.

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Relays. New 4-page bulletin gives basic contact arrangements, ratings, and schematic diagrams of maker's new precision relays.—Henschel Corp., Amesbury, Mass.

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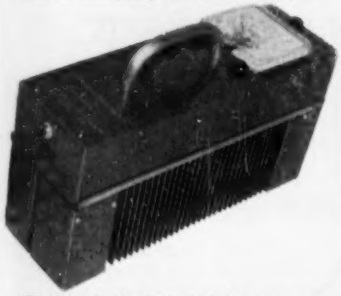
There have been many discussions of the toxic nature of mercury vapor in the technical literature. A bibliography will be sent on request.



Illustrated is Model 23 which has two ranges for versatility. The toxic limit for extended exposure is full scale on the high sensitivity range. Together the ranges provide coverage of concentrations from 0.005 to 3.0 mg./cu. m. Dimensions of all models are 13"x8½"x4½".

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NEW LITERATURE

ELECTRONIC COMPONENTS

Component Handbook. New 320-page Handbook of "Ideas, Techniques, and Designs" covers unitized plug-in components, plugs and connectors, test equipment, computer components, electrical components, government specifications, and special maker's services. Includes many ideas and techniques for use of unitized circuitry, magnetic memories, etc. Write on letterhead to—Dept. HB, Alden Products Co., Brockton, Mass.

Circle **683** on inquiry card.

Electronic Components. New 48-page illustrated Catalog B3 gives features and specifications of maker's antennas and accessories, cables, connectors, plastics, plugs, sockets, and other electronic components.—American Phenolic Corp., 1830 S. 54th Ave., Chicago, Ill.

Circle **684** on inquiry card.

Boron-Carbon Resistors. New 2-page Bulletin B-8 covers applications, tolerance, windings, charts and graphs of maker's molded boron-carbon resistors "Type MBC."—International Resistance Co., 401 N. Broad St., Phila., Pa.

Circle **685** on inquiry card.

Resistors, Capacitors, Switches, Cores. New 56-page illustrated Catalog RC-9 gives electrical and mechanical specifications, dimensions, and application data of maker's standard electronic components including composition resistors, line and slide switches, fixed composition capacitors, ferromagnetic cores, etc.—Stackpole Carbon Co., St. Marys, Pa.

Circle **686** on inquiry card.

Name Plates. New 4-page Bulletin 1 gives features and applications of maker's new "Foilcal" name plates said to have "ease of application of a decal."—Miller Dial & Name Plate Co., 4400 N. Temple City Blvd., El Monte, Calif.

Circle **687** on inquiry card.

Receiving Tube Manual. New 24-page Catalog 1275 covers maker's line of receiving tubes. Includes characteristics and socket connections for over 500 types.—Tube Department, Radio Corp. of America, Harrison, N. J.

Circle **688** on inquiry card.

Power Tube Selection Chart. New chart plots power (watt) output vs. frequency vs. applications for maker's large line of power tubes.—Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y.

Circle **689** on inquiry card.

Horizontal-deflection Amplifier. New 2-page technical information sheet describes performance of maker's new 6CU6 horizontal-deflec-

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with American Electric

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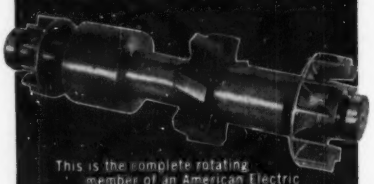

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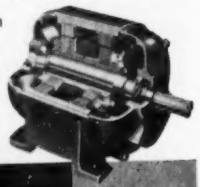

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tion amplifier tube.—CBS Hytron, Danvers, Mass.

Circle **690** on inquiry card.

Miniature Connectors. New 1-page illustrated bulletin presents description and specification of maker's "Series FHL" round miniature feedthrough connectors.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City, N. Y.

Circle **691** on inquiry card.

Plastic Film Capacitors. New 4-page illustrated catalog describes and gives technical data for maker's plastic film capacitors and power packs.—Plastic Capacitors, Inc., 2511 W. Moffat St., Chicago, Ill.

Circle **692** on inquiry card.

RF Cable, Connectors. New 40-page illustrated Catalog D2 gives engineering data on maker's radio-frequency cables and connectors.—American Phenolic Corp., 1830 S. 54th Ave., Chicago, Ill.

Circle **693** on inquiry card.

Electronic Component Catalog. New 224-page illustrated Catalog 54 covers distributor's large lines of transistors, tubes, relays, switches, batteries, power supplies, transformers, capacitors, hi-fi sound equipment, etc. Includes over 30,000 items.—Radio Shack Corp., 167 Washington St., Boston, Mass.

Circle **694** on inquiry card.

Coils, Toroids, Filters. New 12-page illustrated Catalog 101A describes maker's coils, toroids, and filters, including Q curves.—Burnell & Co., Yonkers 2, N. Y.

Circle **695** on inquiry card.

Transistor Components. New 20-page issue, Vol. 18, No. 11 of "The Capacitor" presents articles on miniature components for transistor circuitry and oscilloscope maintenance.—Cornell-Dubilier Electric Corp., Hamilton Blvd., S. Plainfield, N. J.

Circle **696** on inquiry card.

Locking Clips. New 4-page illustrated Bulletin 753-5 presents general information and descriptions of maker's locking clips for holding components.—Atlas E-E Corp., Bedford Airport, Bedford, Mass.

Circle **697** on inquiry card.

Cord Sets, Wire. New 12-page Bulletin CS-1 describes maker's molded parts, plugs, connectors, strain reliefs and junction boxes, flexible cords, etc. —Whitney Blake Co., New Haven 14, Conn.

Circle **698** on inquiry card.

Miniature Terminal Board. New 2-page bulletin describes and illustrates maker's "Series MT" rectangular miniature terminal board.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island 1, N. Y.

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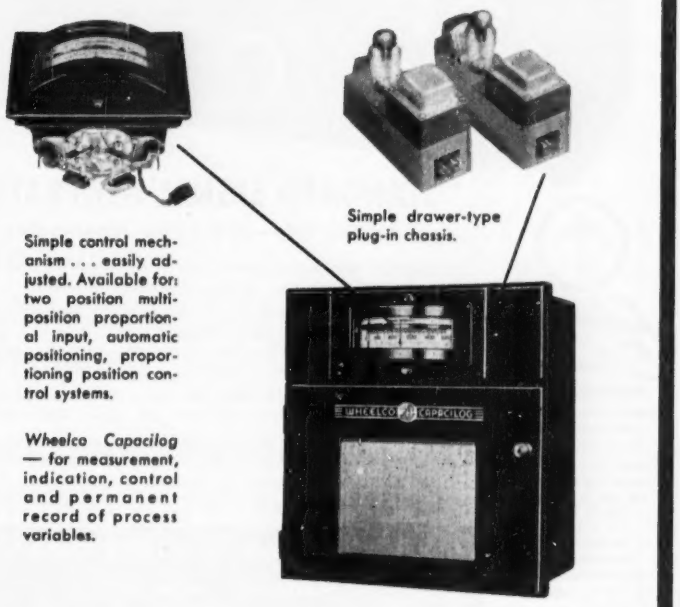
Electronic Enclosures. New 4-page Bulletin 101-CA10M-953 gives features

BARBER COLMAN

Wheelco Recorder-Controllers


Simple control mechanism . . . easily adjusted. Available for: two position multiposition proportional input, automatic positioning, proportioning position control systems.
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NEW LITERATURE

and description of maker's "Emcor" standard flexible enclosure systems for electronic instruments.—Elgin Metalformers Corp., 903 N. Liberty St., Elgin, Ill.

Circle **700** on inquiry card.

Wire Markers. New 2-page bulletin presents features and uses of maker's "Speedy Marx Hi-Temp" wire markers.—North Shore Nameplate Co., Glenwood Landing, L. I., N. Y.

Circle **701** on inquiry card.

Adhesive Labels. New 4-page Bulletin 132 describes maker's self-sticking card-mounted special markers.—W. H. Brady Co., 727 W. Glendale Ave., Milwaukee, Wis.

Circle **702** on inquiry card.

MAGNETS

Permanent Magnets. New 4-page Bulletin PM112 covers general information, properties, and design considerations of maker's permanent magnets, cast grade #7.—Carboloy Dept., General Electric, Detroit, 32, Mich.

Circle **703** on inquiry card.

Powder Cores. New 16-page illustrated Bulletin PC-104 presents history, process, specifications, grading, temperature stabilization, types and characteristics (in graph form) of maker's molybdenum permalloy powder cores.—Arnold Engineering Co., Marengo, Ill.

Circle **704** on inquiry card.

MOTORS

Miniature Motors. New 16-page Bulletin 153 gives schematic diagrams and engineering data on maker's line of miniature electric motors, blower assemblies, and fan assemblies.—Mission Western Engineers, Inc., 132 W. Colorado St., Pasadena, Calif.

Circle **705** on inquiry card.

Fractional-hp. Motors. New 4-page illustrated issue (Vol. 33, No. 6) of "Motorgram" features article on "How to Apply Small Motors to Your Product." Includes characteristics chart of various motor types.—Bodine Electric Co., 2250 W. Ohio St., Chicago, Ill.

Circle **706** on inquiry card.

High-voltage Motor Control. New 16-page illustrated Bulletin GEA-5409 treats operation, application, and special features of maker's "Limitamp" high-voltage industrial motor control.—General Electric Co., Schenectady 5, N. Y.

Circle **707** on inquiry card.

Sub-fractional-hp. Motors. New 18-page illustrated catalog covers application data and motor selection data for maker's sub-fractional-horsepower motors.—Air Marine Motors Inc., 3939 Merrick Rd., Seaford, L. I., N. Y.

Circle **708** on inquiry card.

Hysteresis Motor. New 2-page Bulletin X-3 gives features and descrip-

tions of maker's 400-cycle hysteresis motor, 4-pole type.—Globe Industries, Inc., 1784 Stanley Ave., Dayton, Ohio.
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SPEED

Variable Speed Control. New 4-page illustrated bulletin gives operation, applications, and features of maker's electronic variable speed control for fractional-horsepower motors.—Arrow-Hart and Hegeman Electric Co., 103 Hawthorn St., Hartford, Conn.
Circle **710** on inquiry card.

Speed Changers. New 2-page Technical Data Sheet 10-11 gives applications and specifications of maker's small speed reducers.—Metron Instrument Co., 432 Lincoln St., Denver, Colo.
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SHOP EQUIPMENT

Engraving Machines. New 24-page illustrated catalog presents descriptions, methods and applications of maker's tracer-guided engraving machines for plastics, wood, steel, glass, etc.—New Hermes Engraving Machine Corp., 13-19 University Place, New York, N. Y.
Circle **712** on inquiry card.

Lathes. New Bulletin 5331 D gives features, specifications, attachments and accessories for maker's 9-in. "Model A" bench lathe.—South Bend Lathe Works, South Bend 22, Ind.
Circle **713** on inquiry card.

Gear Trains. New 4-page illustrated bulletin gives general description, specifications, dimensions, and facilities of maker of gear trains and precision gears. Includes kits for experimental purposes.—Bowmar Instrument Corp., 2415 Pennsylvania St., Fort Wayne, Ind.
Circle **714** on inquiry card.

Abrasive Mounted Wheels. New 8-page Catalog 30 presents features, shapes, and finishes of maker's porcelain and resinoid-bonded mounted wheels.—Metal Removal Co., 1546 N. Orleans St., Chicago, Ill.
Circle **715** on inquiry card.

Precision Bore Bars. New 6-page illustrated bulletin gives features and dimensions of maker's precision bore bars for use on drill presses with jig bore accuracy.—Belock Instrument Corp., College Point, N. Y.
Circle **716** on inquiry card.

Miniature Soldering Tool. New 2-page Catalog section C-2B gives features and heating time of maker's small "Thermo-Tip" soldering tool.—Ideal Industries, Inc., Sycamore, Ill.
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Flexible Metal Hose. New 36-page catalog presents maker's line of flexible metal hose, including hose for steam, chemical, lubrication, oil, coolant, platen press, ducting, pneumatic,

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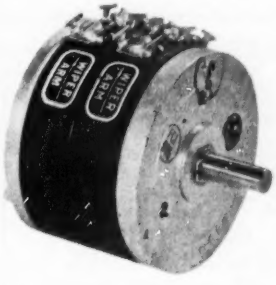
If you're designing a computer or other equipment that requires potentiometers with high electrical and mechanical accuracy, write the Potentiometer Division, Fairchild Camera and Instrument Corporation, 225 Park Avenue, Hicksville, Long Island, Department 140-44B.



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NEW LITERATURE

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MISCELLANEOUS

Stereophonic Sound. New 12-page illustrated Bulletin TB-1 treats maker's multi-directional sound system including stereophonic speakers, magnetic sound head, transfer relay panel, and remote change-over boxes. —Ampex Corp., 934 Charter St., Redwood City, Calif.
Circle **719** on inquiry card.

Air Dryers. New 8-page Bulletin 16.0.081 treats basic process, types, applications, load factors of maker's "Hydryers" for drying instrument air. —J. F. Pritchard & Co., 210 W. 10 St., Kansas City, Mo.
Circle **720** on inquiry card.

Position Indicators. New 2-page illustrated Bulletin MP gives features, applications, operation, construction and typical characteristics of maker's "Microsyn" position indicator that transforms angular displacement into electrical signals.—Doelcam Corp., Soldiers Field Rd., Boston 35, Mass.
Circle **721** on inquiry card.

Platinum Research. New 36-page Bulletin 4367-10-653 presents applications of maker's line of platinum products, including catalytic materials, electrical contacts, rupture discs, laboratory ware and spinnerettes, and treats facilities and research techniques.—Baker and Co., Inc., Newark 5, N. J.
Circle **722** on inquiry card.

Strip Metals. New 6-page illustrated bulletin describes facilities and products of rolling mill which specializes in close tolerance strip metals of all kinds plus producing clad metals.—American Silver Co. Inc., 36-07 Prince St., Flushing, N. Y.
Circle **723** on inquiry card.

Flexible Metal Hose. New 32-page illustrated Catalog 130R covers maker's line of "Flexon" metal hose, including corrugated, convoluted, stainless-steel, and special purpose hoses. —Flexonics Corp., 1409 South Third Ave., Maywood, Ill.
Circle **724** on inquiry card.

Coordinate Cathetometer. New 2-page Bulletin 188-53 describes and illustrates maker's "M1236" coordinate cathetometer for coordinate measurements in a vertical plane.—Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.
Circle **725** on inquiry card.

Coated Fabrics. New 16-page Catalog describes maker's line of industrial coated fabrics, including technical data.—Haartz-Mason, Inc., Watertown 72, Mass.
Circle **726** on inquiry card.

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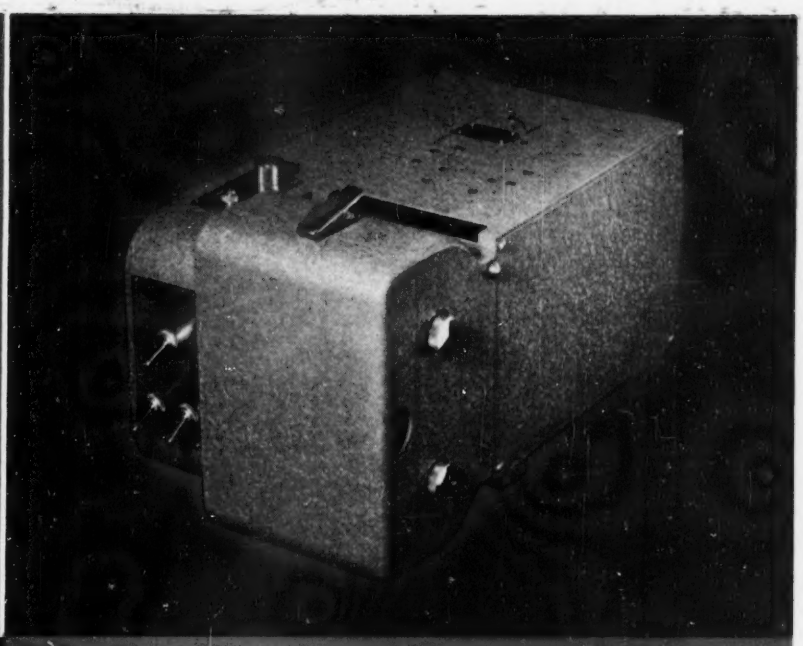

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